

Current practices and expectations to reduce environmental impact of electrophysiology catheters : results from an EHRA/LIRYC European physician survey

Boussuge-Roze, J.; Boveda, S.; Mahida, S.; Anić, Ante; Conte, G.; Chun, J. K. R.; Marijon, E.; Sacher, F.; Jais, P.

Source / Izvornik: **Europace, 2022, 24, 1300 - 1306**

Journal article, Published version

Rad u časopisu, Objavljena verzija rada (izdavačev PDF)

<https://doi.org/10.1093/europace/euac085>

Permanent link / Trajna poveznica: <https://um.nsk.hr/um:nbn:hr:266:462314>

Rights / Prava: [In copyright](#)/[Zaštićeno autorskim pravom.](#)

Download date / Datum preuzimanja: **2023-09-24**



**Klinički
bolnički
centar
Split**

Repository / Repozitorij:

[University Hospital of Split Digital Repository](#)



Current practices and expectations to reduce environmental impact of electrophysiology catheters: results from an EHRA/LIRYC European physician survey

Julie Boussuge-Roze ^{1,2*}, **Serge Boveda** ^{3,4}, **Saagar Mahida**^{1,5}, **Ante Anic** ⁶, **Giulio Conte**⁷, **Julian K.R. Chun**⁸, **Eloi Marijon**⁹, **Frederic Sacher**^{1,2}, and **Pierre Jais**^{1,2}

¹Electrophysiology and Heart Modelling institute, IHU Liryc, Univ. Bordeaux, INSERM, CRCTB, U 1045, Campus Xavier Arnoz - Avenue du Haut-Leveque, F-33600 Pessac, France; ²CHU de Bordeaux, Department of Electrophysiology and Cardiac Stimulation, F-33000 Bordeaux, France; ³Clinique Pasteur, Heart Rhythm Department, Toulouse, France; ⁴Universiteit Ziekenhuis Brussel - VUB, Brussels, Belgium; ⁵Department of Cardiac Electrophysiology, Liverpool Heart and Chest Hospital, NHS Trust, UK; ⁶University Hospital Centre Split, Department for Cardiovascular diseases, Split, Croatia; ⁷Cardiology Department, Cardiocentro Ticino Institute, Ente Ospedaliero Cantonale, Lugano, Switzerland; ⁸CCB, Cardiology, Med. Klinik III, Markuskrankenhaus, Frankfurt, Germany; and ⁹European Georges Pompidou Hospital and Paris City University, Cardiology Department, Paris, France

Received 29 April 2022; accepted 13 May 2022

Abstract

The healthcare sector accounts for nearly 5% of global greenhouse gas emissions (GHG) and is a significant contributor to complex waste. Reducing the environmental impact of technology-heavy medical fields such as cardiac electrophysiology (EP) is a priority. The aim of this survey was to investigate the practice and expectations in European centres on EP catheters environmental sustainability. A 24-item online questionnaire on EP catheters sustainability was disseminated by the EHRA Scientific Initiatives Committee in collaboration with the Liryc Institute. A total of 278 physicians from 42 centres were polled; 62% were motivated to reduce the environmental impact of EP procedures. It was reported that 50% of mapping catheters and 53% of ablation catheters are usually discarded to medical waste, and only 20% and 14% of mapping and ablation catheters re-used. Yet, re-use of catheters was the most commonly cited potential sustainability solution (60% and 57% of physicians for mapping and ablation catheters, respectively). The majority of 69% currently discarded packaging. Reduced (42%) and reusable (39%) packaging also featured prominently as potential sustainable solutions. Lack of engagement from host institutions was the most commonly cited barrier to sustainable practices (59%). Complexity of the process and challenges to behavioral change were other commonly cited barriers (48% and 47%, respectively). The most commonly cited solutions towards more sustainable practices were regulatory changes (31%), education (19%), and product after-use recommendations (19%). In conclusion, EP physicians demonstrate high motivation towards sustainable practices. However, significant engagement and behavioural change, at local institution, regulatory and industry level is required before sustainable practices can be embedded into routine care.

Keywords

Electrophysiology catheter • Environmental impact • Sustainability • Recycling • Reuse • Reprocessing • Circular economy • EHRA survey

Introduction

While healthcare services are critical for human well-being, they are also major drivers of environmental damage. Healthcare accounts for

4.6% of the global greenhouse gas emissions (GHGs).¹ To put it in perspective, if healthcare was a country, it would be the fifth largest greenhouse gas emitter on the planet, with 71% of emissions coming from the product supply chains.² Furthermore, healthcare is an important consumer of critical resources and generates large amounts

* Corresponding author. Tel: +33 662632960, E-mail address: julie.boussuge-roze@ihu-liryc.fr

© The Author(s) 2022. Published by Oxford University Press on behalf of the European Society of Cardiology. All rights reserved. For permissions, please email: journals.permissions@oup.com.

What's new?

- This is the first comprehensive survey on sustainability practices in electrophysiology.
- Close to two-thirds of participating physicians demonstrate motivation to sustainable practices.
- More than half of catheters and more than two-thirds of packaging are discarded directly after use in the polled centres.
- Close to two-thirds of physicians consider reusing as the most effective strategy to improve sustainability for mapping and ablation catheters.
- Regulatory changes, education, and specific recommendations from manufacturing companies were identified as the best enablers towards more sustainable practices.

of complicated waste.³ Reducing the environmental impact of healthcare has emerged as an important challenge.^{4,5,6}

Cardiac electrophysiology (EP) is a technology-heavy medical field involving a high proportion of single-use medical devices with very short lifetimes. In 2019, more than 1 million catheter ablation procedures were performed worldwide.⁷ These procedures commonly require multiple mapping and ablation catheters, long sheaths and needles for transseptal access, which are typically only used for a few hours. Single-use translates into plastics, metals, rare metals, printed circuit boards, and microchips being discarded directly after the ablation procedure.

Electrophysiology is therefore predicted to contribute significantly to the overall environmental impact of healthcare, in terms of resource consumption, harmful emissions and complex waste generation. Reducing the environmental impact of EP is complex. One of the major constraints is a need to deliver high quality medical care and to guarantee safety for patients. These constraints have encouraged the prevailing single-use culture.

We aimed to investigate the current practice and expectations of European EP centres in terms of environmental sustainability, with a focus on EP catheters.

Methods

An online questionnaire was prepared by the Scientific Initiatives Committee of the European Heart Rhythm Association (EHRA) in collaboration with the Liryc Institute (Bordeaux, France). The questionnaire was disseminated through the EHRA Scientific Research Network members, national EP groups, and social media platforms (Twitter, LinkedIn and Facebook). A 24-item questionnaire polled European EP centres on EP catheters sustainability practices and expectations, between November 1st to November 30th 2021. The questionnaire was subdivided in three blocks:

- (1) Centre-based current practices regarding sustainability in EP
- (2) Analysis of motivation to reduce environmental impact
- (3) Analysis of expectations regarding sustainability

The full questionnaire is included in the [Supplemental methods](#) section.

Statistical analysis

Data are expressed as numbers and percentages. χ^2 test analysis was used to analyze potential interactions between survey responses and characteristics of polled physicians.

Results

Survey participants

The survey was opened by 318 participants and 278 (87%) sent fully completed responses (42 countries; 76% male, average age 43 years). Eighty-seven percentage of participants were from public hospitals [atrial fibrillation (AF) procedure volume: 11% <100/year; 53% 100–500/year; 36% >500/year]. In terms of catheter use (including long-sheaths) for each AF ablation procedure, 34% used two catheters; 30% used three catheters and 16% used four catheters. The number of respondents in the European centres is reported in [Figure 1](#).

Current sustainability practices

The results of the survey in relation to catheter management post-procedure are reported in [Figure 2](#). Mapping and ablation catheters were discarded post-procedure by 50 and 53% polled physicians, respectively. Partial catheter recycling (platinum from electrodes) was performed by 23 and 26% of polled physicians, respectively. Local sterilization of mapping and ablation catheters was used only by 12 and 9% of polled physicians, respectively. External reprocessing was used for only 8 and 5% mapping and ablation catheters, respectively. Catheter packaging was discarded in medical or general waste by 69% and recycled by 19% of respondents.

Motivation to reduce environmental impact

The results of the survey in relation to overall motivation to reduce environmental impact and the potential barriers to environmental efforts are reported in [Figure 3](#) and [Figure 4](#), respectively. Eighty-two percent of polled physicians were highly motivated in relation to environmental issues in their personal lives. Sixty-two percent were motivated in reducing the environmental impact of their EP practice in general. Sixty and Fifty percent of polled physicians indicated that they would select alternative mapping or ablation catheters to reduce their environmental impact, respectively, if catheter performance was preserved.

In terms of the barriers to reducing the environmental impact of EP centres, the most significant perceived barrier by polled physicians was a lack of engagement from the host institution (59%). Only 16% of centres had an executive in charge of environmental sustainability. Other potential barriers included complexity of sustainability processes (48%), difficulty in changing behaviours (47%), infectious risk (41%), lack of training/awareness (37%), and cost implications (33%).

Expectations regarding sustainability

Physicians' expectations regarding sustainability and potential enablers towards sustainable practices are reported in [Figure 5](#) and [Figure 6](#), respectively. In terms of the specific strategy for improving EP catheter sustainability, reuse of mapping and ablation catheters in their entirety was the most commonly cited solution (60 and 57% of

polled physicians, respectively). Of note, catheter reuse is currently authorized in the European Union under the Medical Device Regulation (MDR) (EU) 2017/745-Art.17⁸ only if permitted by national law and under specific requirements. Therefore, not all the centres had regulatory permission to reuse catheters. Information on regulatory status stated regarding reuse after sterilization or reprocessing in different countries of respondents is included in [Figure 1](#). In relation to packaging, potential solutions included reducing volume (42%), reusable packaging (39%), reducing volume of shipping packaging (26%), improving packaging recyclability (24%), and improving packaging recyclability by provision of clear recycling instructions (16%).

In terms of enablers towards more sustainable practices, evolution of regulations to allow for catheter reuse was cited as an important potential solution by the majority of physicians (31%). Other potential solutions included education on best practices (19%), recommendations from companies on post-procedure use (19%), financial incentives (14%), and take-back services from companies (13%). A more detailed breakdown of physicians' suggestions to reduce the environmental impact of EP procedures included in [Supplementary material online, Table S1](#).

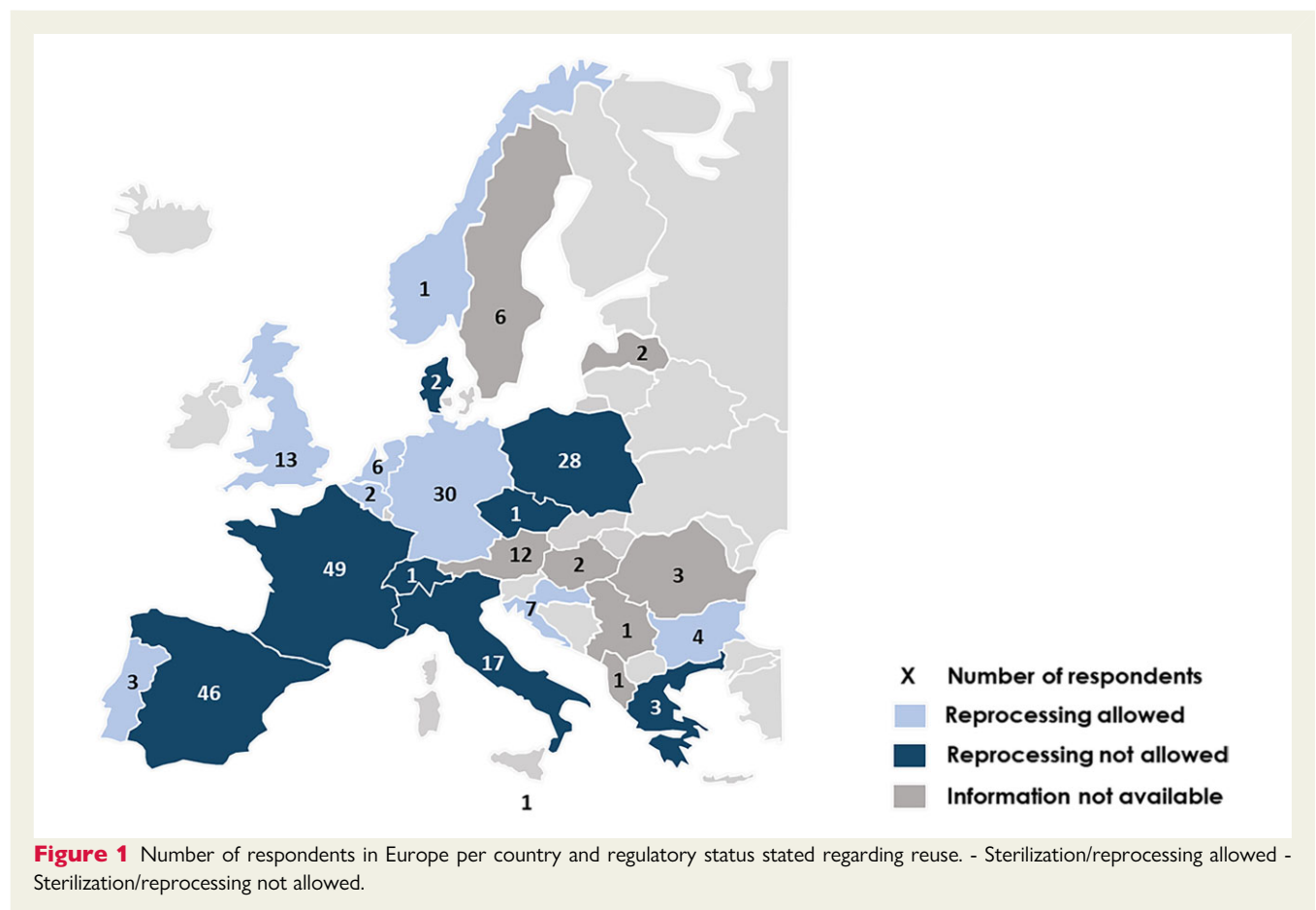
Interaction between physician characteristics and responses

There were no significant interactions between the age, gender, types of practice, country of origin, or level of experience of polled physicians and the responses to the survey.

Discussion

The main findings of this large European survey are as follows: (i) close to two-thirds of physicians demonstrate motivation towards sustainable EP practices. (ii) More than half of catheters and more than two-thirds of packaging are currently discarded directly after use. (iii) Catheter reuse after internal sterilization or external reprocessing occurs in a minority of cases (one fifth or less, depending on catheter type). (iv) Nearly two-thirds of physicians consider reusing as the most effective strategy for more sustainable practice. (v) More than half of the physicians would favour sustainable mapping and ablation catheters, if performance were preserved. (vi) Lack of engagement from host institutions was the most commonly cited barrier to sustainable practices (59%). (vii) Up to half of the polled physicians also cited complexity of the process and challenges to behavioural change as barriers to sustainable practices. (viii) In terms of potential solutions, regulatory changes (31%), education (19%), and specific after-use recommendations by companies (19%) featured prominently.

Addressing the environmental impact of healthcare has become a priority and technology-heavy specialties such as cardiac EP represent important targets for sustainable practices. The overall environmental impact of ablation procedures, taking into consideration ablation catheters and other consumables, has not yet been systematically evaluated. Single-use EP catheters are predicted to be major contributors in this context, considering their nature and high number. Our survey demonstrated that the vast majority of centres



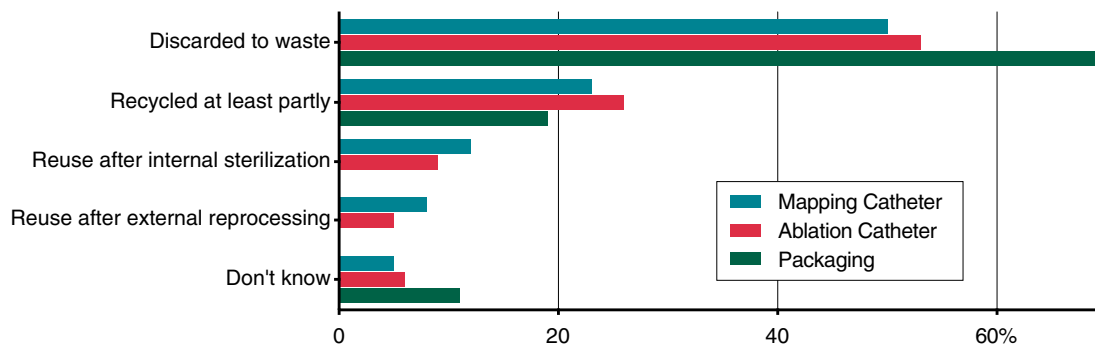


Figure 2 Destination of mapping catheters, ablation catheters, and packaging after use (percentages indicating the items selected as priorities in 1st position).

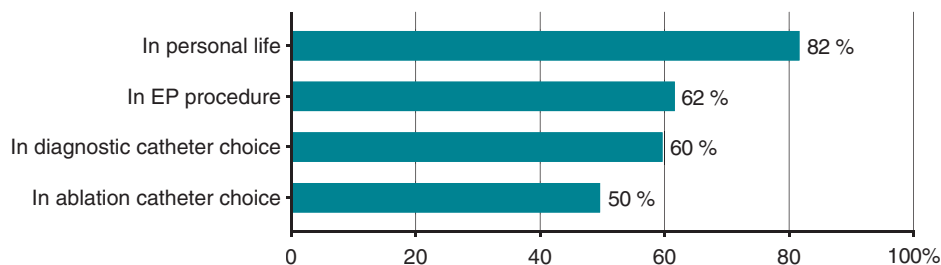


Figure 3 Motivation to reduce environmental impact (percentages are displaying the top two choices on a scale from 1 to 5).

currently discard EP catheters and packaging post-procedure, a practice in keeping with a typical linear economy model of 'take-make-dispose', rather than circular practices as illustrated in [Figure 7](#). This linear model is associated with multiple adverse environmental effects including natural resource consumption, carbon emissions, and waste generation.

A majority of polled physicians support more circular practices involving catheter reuse, development of novel sustainable catheter designs, and reusable packaging. While physician engagement is critical, it is only part of the solution and current prevailing practices at the majority of centres do not favour sustainability. We identified barriers at multiple levels that need to be overcome before sustainable practices can be embedded into routine practice. For instance, lack of engagement from their institutions was cited as a major barrier by a significant proportion of physicians. The complexity of the sustainability processes was also identified as an important barrier. This barrier is particularly relevant for EP catheters, which by their nature are complex. Recycling of complex products is not a straightforward process. It requires specific expertise, detailed knowledge of product composition (which is not routinely available), as well as specific on-site recycling streams.^{9,10}

In addition to barriers to recycling, for a number of European centres, major barriers to sustainable practices were identified at a policy-level. Specifically, routine reuse of catheters after sterilization or reprocessing is currently illegal in multiple European countries. In

recent decades, policies against catheter recycling have largely been developed to mitigate against risk of infection. Interestingly, a potential risk of infection was cited as the fourth most common obstacle to environmental efforts in our survey. However, available evidence indicates that with appropriate oversight, standardization, and validation of practice, catheter reprocessing and reuse is feasible, safe, and cost effective.^{11–14} Overall, our survey highlights the need for a review of national policies against catheter reusing as a priority, especially given the fact that reuse after reprocessing is authorized under the European Medical Devices Regulations (EU) 2017/745. To date clear visibility on whether each EU member states decided to allow reprocessing and further use of single-use devices or not under the MDR is missing.

Our survey demonstrates a global consensus in EP with a high level of engagement from physicians to promote more sustainable practices. Specifically, the majority of physicians support reuse of catheters, new sustainable catheters by design, reduced and reusable packaging. Based on previous studies, reusing mapping catheters is predicted to reduce by 50.4% the global warming impact compared to newly manufactured catheters.¹⁵

Reusing and recycling complex products to improve sustainability remains challenging and highlights the need for new paradigms with longer term perspectives.¹⁶ A number of novel solutions to promote sustainability require collaborative working models between physicians, healthcare systems and industry.¹⁷ Healthcare systems are

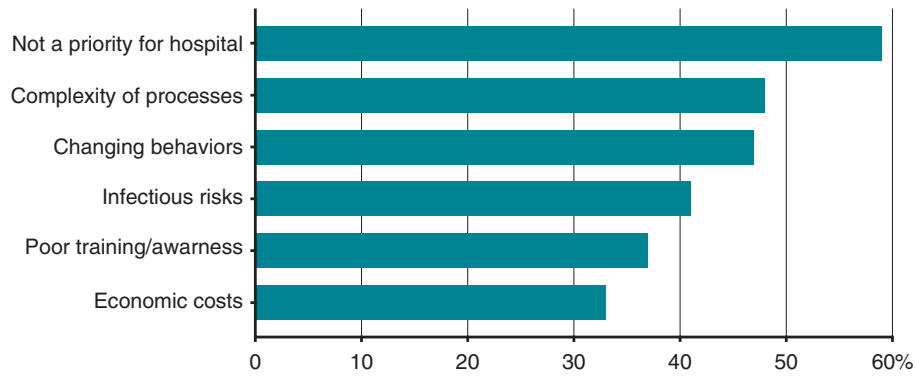


Figure 4 Main perceived obstacles to environmental efforts. (Percentages of respondents selecting the item among the top three obstacles).

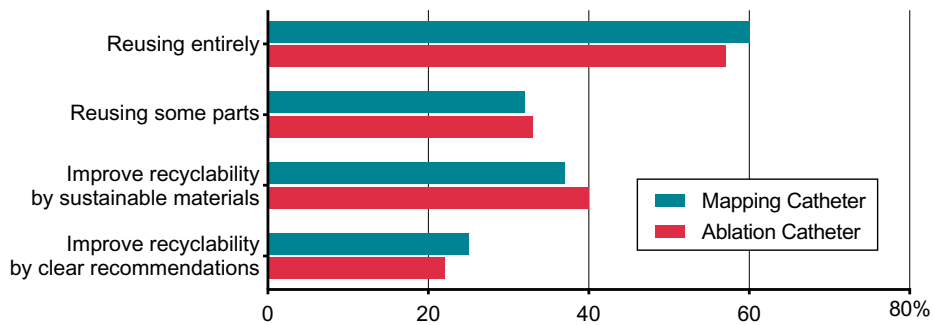


Figure 5 Potential solutions for improving sustainability. (Percentages of respondents selecting a solution in 1st or 2nd position). In the left panel, percentages in red refer to mapping catheters, whereas those in black indicate refer to ablation catheters.

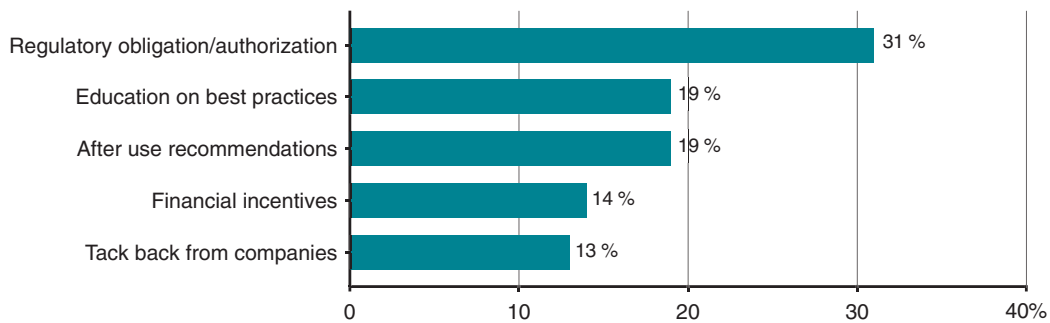
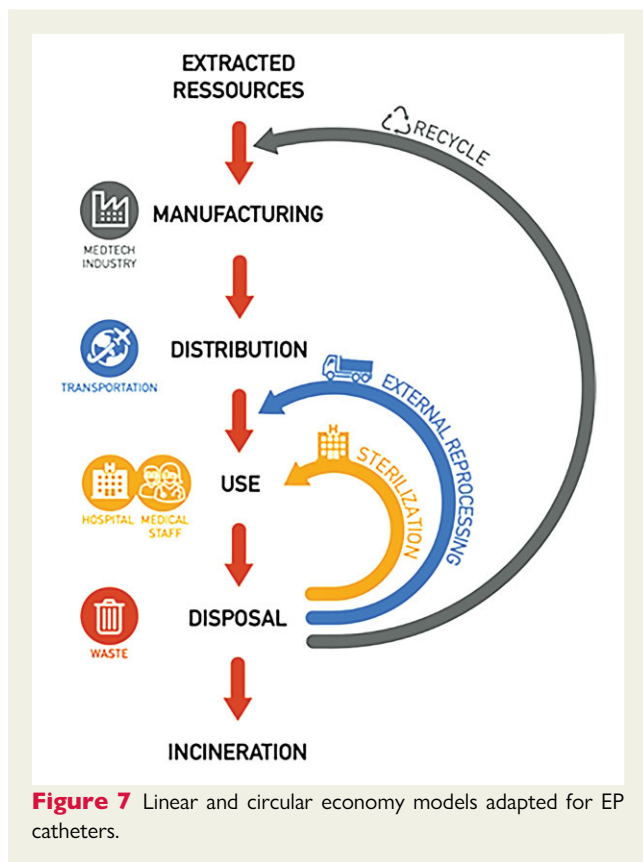


Figure 6 Enablers towards more sustainable practice (percentages indicating the items selected as priorities in 1st position).

consistently searching for strategies to reduce costs while maintaining a high standard of care. There are a number of institutional-level innovative models of working that could promote sustainable practices and reduce cost burden.¹⁸ Potential solutions include financial incentives for catheter reuse, development of pathways for catheter reprocessing and recycling, and institution-level, or indeed policy-level mandates to purchase catheters that lend themselves to sustainable practices.

Our findings underscore the importance of a collaborative approach with industry to develop innovative products and services to promote sustainable practices. Being a key component of the equation, industry will have to be a driving force. Our field needs collaborative initiatives with multiple stakeholders, including regulators, hospitals, industry, and physicians to facilitate development of novel reusable and recyclable catheters designs.¹⁹ In addition, innovative



recycling techniques and novel circular business models such as payment per procedure, multi-use high quality catheters associated with take-back, and reprocessing services²⁰ are needed to promote sustainable practices.

Limitations

The present survey has a certain number of limitations. First, the representation from France, Spain, Germany, and Poland was higher, which could have introduced some bias. Second, the laws differ between countries in relation to the ability to reuse catheters and these legal aspects could have influenced physicians' responses. Finally, surveys are in essence subjected to bias due to their non-compulsory nature.

Conclusions

Electrophysiology healthcare professionals demonstrate motivation to adopt sustainable practices. However, significant engagement and behavioural change, at local institution, regulatory and industry level is required before sustainable practices can be embedded into routine care.

Supplementary material

Supplementary material is available at *Europace* online.

Acknowledgements

The production of this document is under the responsibility of the EHRA Scientific Initiatives Committee: Serge Boveda (Chair), Giulio Conte (Co-Chair), Ante Anic, Sergio Barra, Julian K.R. Chun, Carlo de Asmundis, Nikolaos Dargres, Michal M. Farkowski, Jose Guerra, Konstantinos E. Iliodromitis, Kristine Jubele, Jędrzej Kosiuk, Eloi Marijon, Rui Providencia, and Frits Prinzen. The authors acknowledge the EHRA Scientific Research Network centres for participating in the survey. The authors are deeply grateful to Vanessa Meyen for her support in conducting the survey and to Xavier Legentil and Virginie Mekongo for data-management and data-analysis support. This study has been conducted within the framework of the Postgraduate Certificate in Sustainable Business at the University of Cambridge.

Funding

This work was supported by the French Government as part of the 'Investments of the Future' programme managed by the French National Research Agency (ANR) (grant number ANR-10-IAHU-04); and by Boston Scientific as part of an educational grant to (JBR).

Conflicts of interest: J.B.-R.: educational grant from Boston Scientific. S.B.: consultant for Medtronic, Boston Scientific, Microport, Zoll; A.A.: consulting fees and speaking honoraria: Boston Scientific Inc., FarapulseInc., Galaxy Medical Inc., Biosense&Webster—Contracted research: Boston Scientific Inc., FarapulseInc., Galaxy Medical Inc., Biosense&Webster; S.M.: speaking honoraria, consulting fees, research funding from Biosense Webster—Speaking honoraria from Abbott and Boston Scientific Frederic Sacher: Speaking Honorarium modest: Biosense Webster, Boston Scientific, Abbott, Microport, Bayer—Salary from Inheart; P.J.: lecture fees: Biosense Webster, Boston Scientific—Shareholder: Affera; G.C., J.K.R.C. and E.M.: No conflicts of interests.

Data availability

The data are available from the corresponding author on request.

References

- Watts N, Amann M, Arnell N, Ayeb-Karlsson S, Belesova K, Boykoff M, et al. The 2019 report of The Lancet Countdown on health and climate change: ensuring that the health of a child born today is not defined by a changing climate. *Lancet* 2019;**394**:1836–1878.
- Karliner J, Slotterback S, Boyd R, Ashby B, Steele K. Health care's climate footprint: how the health sector contributes to the global climate crisis and opportunities for action. Health care without harm climate – smart health care series. Green Paper Number One produced in collaboration with Arup. 2019.
- Guzzo D, Carvalho MM, Balkenende R, Mascarenhas J. Circular business models in the medical device industry: paths towards sustainable healthcare. *Resour Conserv Recycl* 2020;**160**:104904.
- Lenzen M, Malik A, Li M, Fry J, Weisz H, Pichler PP, et al. The environmental footprint of health care: a global assessment. *Lancet Planet Heal* 2020;**4**:e271–e279.
- Sherman JD, Thiel C, MacNeill A, Eckelman MJ, Dubrow R, Hopf H, et al. The Green Print: advancement of environmental sustainability in healthcare. *Resour Conserv Recycl* 2020;**161**:104882.
- Eckelman MJ, Sherman J. Environmental impacts of the U.S. health care system and effects on public health. *PLoS One* 2016;**11**:e0157014.
- Worldwide Cardiac Ablation Catheters Industry to 2025 - US. <https://www.globenewswire.com/news-release/2021/07/13/2261690/28124/en/Worldwide-Cardiac-Ablation-Catheters-Industry-to-2025-US-is-Expected-to-Experience-the-Most-Rapid-Growth.html> (accessed 12 Apr 2022).
- REGULATION (EU) 2017/745 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL - of 5 April 2017 - on medical devices, amending Directive 2001/83/EC, Regulation (EC) No 178/2002 and Regulation (EC) No 1223/2009 and repealing Council Directives 90/385/EEC and 93/42/EEC.
- Chalkidou K, Appleby J. Eliminating waste in healthcare spending. *BMJ* 2017;**356**:j570.
- Windfeld ES, Brooks MSL. Medical waste management - a review. *J Environ Manage* 2015;**163**:98–108.

11. Leichsenring ML, Psaltikidis EM, de Oliveira Figueiredo MJ, Moretti ML, Trabasso P. Conception and validation of a protocol for reuse of non-irrigated electrophysiology catheters in a Brazilian teaching hospital. *J Interv Card Electrophysiol* 2017;**51**:45–50.
12. Leung LW, Evranos B, Grimster A, Li A, Norman M, Bajpai A, et al. Remanufactured circular mapping catheters: safety, effectiveness and cost. *J Interv Card Electrophysiol* 2019;**56**:205–211.
13. Thomas C, Crawford KAE. Reuse of catheters and devices labelled for single use: evidence, recommendations and oversight. *Heart Asia* 2018;**10**:e011033.
14. Duncker D, Svetlosak M, Guerra F, Vivien Nagy K, Vanduyhoven P, Mikhaylov EN, et al. Reprocessing of electrophysiology material in EHRA countries: an EHRA Young EP survey. *Eurospace* 2021;**23**:479–485.
15. Schulte A, Maga D, Thonemann N. Combining life cycle assessment and circularity assessment to analyze environmental impacts of the medical remanufacturing of electrophysiology catheters. *Sustainability* 2021;**13**:898.
16. Sousa AC, Veiga A, Maurício AC, Lopes MA, Santos D, Neto B. Assessment of the environmental impacts of medical devices: a review 2021;**23**:9641–9666.
17. Macneill AJ, Hopf H, Khanuja A, Alizamir S, Bilec M, Eckelman MJ, et al. Transforming the medical device industry: road map to a circular economy. *Health Aff* 2020;**39**:2088–2097.
18. Hede S, Jose M, Nunes L, Fernanda P, Ferreira V, Rocha LA. Incorporating sustainability in decision-making for medical device development. *Technol Soc* 2013;**35**:276–293.
19. Wilson AL, Timmins KA, Allen RF, Jones PM, Ware SL, Boddington D, et al. Initial experience with a novel re-sterilisable decapolar electrophysiology catheter. *J Interv Card Electrophysiol* 2020;**58**:177–183.
20. Kane GM, Bakker CA, Balkenende AR. Towards design strategies for circular medical products. *Resour Conserv Recycl* 2018;**135**:38–47.