

# Environmental Sustainability in the Cardiac Catheter Laboratory



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The health care sector contributes to nearly 5% of global carbon emissions with the exponential growth of medical waste posing a significant challenge to environmental sustainability. As the impact of climate change on individuals and population health becomes increasingly more apparent, the health care system's significant impact on the environment is also raising concerns. Hospitals contribute disproportionately to health care waste with the majority arising from resource intensive areas such as operating theatres and cardiac catheter labs (CCLs). Despite the growing volume of cardiac procedures worldwide, initiatives to reduce waste from CCLs have received limited attention, overlooking opportunities for significant reduction in operational costs and carbon footprint. We aim to raise awareness of the current landscape of waste management in CCLs. We identify areas of resource optimisation and highlight practical strategies and frameworks employed elsewhere in health care to reduce waste. Importantly, we hope to empower health care workers in CCLs to make a meaningful change to their practice and contribute towards a more sustainable future.

## Keywords

Environment • Sustainable • Waste • Green • Recycling • Cath-lab

## Introduction

Environmental sustainability has evolved into a major societal focus with increasing awareness of climate change and its potentially catastrophic impact on our health and the environment [1]. In response, the United Nations declared the next 10 years to be a 'decade of action' and, as part of its 2030 Sustainable Development goals, identified reduced material consumption and improved waste management as key drivers of change [2]. The health care sector contributes to nearly 5% of global carbon emissions with the exponential growth of medical waste posing significant challenges to environmental sustainability [3]. Those working in the cardiac catheter lab (CCL) need not look far to see the amount of waste created during each procedure (Figure 1). Despite this,

a search of PubMed until 1 April 2022 for 'cath lab', 'catheterization lab', 'cardiac lab' combined with the terms 'sustainability', 'environment', 'waste', 'recycling' or 'green' yielded no results. It is similarly telling that, as far we know, no major interventional cardiology conference scheduled in 2020 or 2021 had waste management or sustainability on its agenda. As health care professionals, it is important for us to recognise and actively work towards reducing the impact of our services on the environment as the consequences of climate change on individual and population health are becoming increasingly more apparent [1].

Assessing the current resource and waste management practices within our CCLs presents a meaningful opportunity to not only facilitate excellent health outcomes for patients but also deliver broader economic, social and



**Figure 1** An example of the waste produced from performing percutaneous coronary intervention to a bifurcation lesion.

environmental benefits. This in turn would pave the way towards a more environmentally sustainable health care system which the World Health Organization defines as one that ‘improves, maintains or restores health while minimizing negative impacts on the environment and leveraging opportunities to restore and improve it, to the benefit of the health and well being of current and future generations’ [4]. While effective decarbonisation of the Australian health system will require collaborative efforts throughout the value chain, including redesigning health systems and hospital energy sources, strategies to limit material consumption and waste as part of clinical care is a critical step towards sustainability [5].

Through this article, we aim to raise awareness and empower interventional cardiologists, nurses, and other health care workers in the CCL to lead with ‘greener’ and more sustainable practices. This is particularly pertinent for fellows in training and early career cardiologists as they are poised to become future leaders in the field, with the ability and responsibility to lead change. Efforts made early in their careers to instill more sustainable and environmentally friendly behaviours can have vast, far reaching benefits in the decades to come.

## The Current Situation

The Australian health care sector contributes 7% of national carbon emissions which, for comparison, is equivalent to emissions from all activities in the state of South Australia [6]. In its path to reducing carbon emissions, sustainable and safe management of health care waste (HCW) is a complex challenge facing health systems and the broader society. Over the last 40 years in Australia, HCW has become the second largest contributor to waste nationwide, behind only the food industry [7]. Hospitals disproportionately contribute to HCW as they consume a large amount of resources with resource intensive procedural facilities such as operating rooms and labour wards contributing to over 70% of hospital waste production [8]. Several factors have been implicated in the growth of HCW including population growth, expansion of medical facilities and the trend away

from multiple use equipment towards single use, safer and more cost-effective items [9].

The CCL has not been immune to this trend with standard practice employing single use items including drapes, gowns, gloves, plastic bowls, syringes, manifolds, catheters and angioplasty balloons as well as the single use plastic many of these items are packaged in. Additionally, most CCLs have pre-made ‘cath lab packs’ and it is not uncommon to find items in these packs that are never used. As most of these items—both used and unused—are either incinerated or destined for landfill, it is not difficult to comprehend that, with over one million cardiac catheterisation procedures performed annually in the US alone, this clearly results in a significant environmental footprint globally [10]. Importantly, the volume of procedures means that even small efforts to reduce waste can have a material positive impact towards sustainability.

## Strategies for Health Care Workers in Cardiac Catheter Labs

In this section, we suggest five strategies as a starting point to empower all health care providers in the CCL to minimise wastage and make the CCL more environmentally sustainable, noting that a comprehensive decarbonisation strategy for health systems is beyond the scope of this article. At the outset, it should be noted that any strategy must keep patient safety as paramount.

### Strategy 1: Acknowledge the Issue and Start a Discussion

Clinician awareness and active participation are critical components of resource and waste management [11]. To move towards more sustainable practices in our own institutions, we must first acknowledge the significant waste produced by CCLs and take ownership of it. We believe it is our responsibility as health care providers to highlight the issue and lead by example. While a collaborative approach between clinicians, hospital administrators and policy makers is required for system-wide changes in policy and practice, health care providers can begin the conversation and raise awareness with their CCL teams in order to examine potential areas of waste minimisation. Education and empowerment of teams to promote ideas for waste management is important with an emphasis on the significant benefits that can be gained in the future from small measures made today. Collaboration of ideas and healthy competition between institutions should be fostered through whichever means necessary including social media (suggested hashtag #greencathlab).

### Strategy 2: Seek Appropriate Non-Invasive Investigations

As the number of procedures in a CCL is directly related to the volume of waste production, performing only necessary

invasive angiography is a simple potential mechanism to reduce waste. Invasive angiography is still commonly used early in the diagnostic pathway in patients with suspected coronary disease despite the widespread availability of non-invasive modalities such as stress echocardiography, cardiac magnetic resonance imaging (MRI) and computed tomography (CT) coronary angiography. A number of peak medical colleges and societies including The Royal Australian College of Surgeons and Australasian College of Emergency Medicine have promoted ‘Choosing Wisely’ which is a national health care initiative to promote dialogue on unnecessary tests and procedures [12]. With an estimated 60% of elective cardiac catheterisations finding no obstructive disease, appropriately utilising non-invasive modalities when indicated and available would significantly reduce material consumption and waste from the CCL [13].

### Strategy 3: “The Five R-Concept”: Reduce, Reuse, Recycle, Rethink and Research

Adopting a ‘lean’ mentality in the CCL and reviewing processes through waste minimisation principles may help avoid the use of unnecessary equipment and material [14]. Fundamentally, a movement away from our current ‘linear’ mode of resource use, where products are destroyed at the end of their life creating waste and depleting natural resources, to a ‘circular’ model, which focusses on efficient use and re-use of natural resources such that waste is minimised or completely reused, is crucial [9]. As part of this transition, the ‘5R-concept’ (reduce, reuse, recycle, rethink, and research) can be an important framework in developing programs for rational use of resources and participation by health care workers in the CCL [15].

Firstly, as noted previously, many items in the “cath lab packs” are never or seldom used and contribute to unnecessary waste production without any additional benefit to patient care. In a study of a United States (US) plastic surgery department, judicious selection of instruments and revised contents of disposable packs to remove extraneous items significantly reduced the amount of opened material and operating room waste [16]. Cardiologists should challenge, engage and collaborate with manufacturers to review redundant items in commonly used equipment and item packs. This should ideally be done through their health care institutions who usually have considerable bargaining power against manufacturers [17]. In 2021, New Zealand’s Tauranga Hospital’s CCL team worked to change, amongst other things, their catheter lab packs to reduce redundant items and were able to reduce landfill waste by 7% in their preliminary results [18]. Alternatives to bulky packaging, which is especially apparent with angioplasty balloons, should also be essential when redesigning packs. Currently, angioplasty balloons come packaged in cardboard boxes and encased within plastic hard shells with balloon packs also including paper instructions on usage and balloon pressures. It is clear significant improvements can be made, if sought. In addition to optimisation of

procedural packs, a major source of waste in operating rooms is items requested to be opened by the proceduralist on the sterile field but not used during the procedure [19]. For the interventional cardiologist, reflecting upon similar requests for items that are rarely used or not used provides another opportunity to reduce unnecessary waste.

Secondly, where possible and safe, we should try to re-use supplies—which has become increasingly difficult given the trend towards single-use items in Australia and other high resource settings. A recent study comparing the lifetime environmental effects of reusable versus single use surgical gowns demonstrated reusable gowns reduce solid waste generation by 84% and greenhouse gas emissions by 66% [20]. However, some smaller previous studies published conflicting results of the environmental benefit of reusable surgical items and therefore institutions should conduct further cost-benefit analyses of their own health system prior to making system wide changes [20]. Moreover, procedural items may also be reused, as Milasinovic et al. describe judicious use of equipment in performing bifurcation percutaneous coronary intervention (PCI) via a resource tailored approach [21]. Although resources may be plentiful in many institutions, this study is still a valuable resource for individuals looking to make changes in their own practice.

Finally, maximising recycling reduces the amount of waste from the CCL that ends up in landfill. While simple in principle, it can be challenging to implement in the CCL due to the potential of exposure to biological hazards. However, a CCL team in Stanford has demonstrated the diversion of 12 tonnes of material from landfill per year via simple green initiatives such as a green bag for recyclable waste in addition to linen bags and medical waste bags, resulting in 15% of total waste by weight being recycled per case [22]. A clear and visual list of items that can be safely recycled such as hard plastics, cardboard and packaging of catheters and devices and those that are non-recyclable should be clearly displayed. Importantly, further research and innovation towards implementation of a ‘circular economy’ of waste to prevent, minimise or completely reuse waste in the health care context is necessary to move away from the traditional plastic management model (production-use-disposal) that is currently commonplace [23].

### Strategy 4: Implementation More Important Than Policy

A coherent and clear waste reduction policy is necessary and should be communicated with the CCL team. However, previous experience in three separate local health districts in NSW has demonstrated that although policy is essential, implementation is the primary driver of change [24]. To realise the above goal of a ‘leaner’ CCL, ‘operational efficiency’ is key and relates to the ability to deliver services in a cost-effective manner while maintaining high quality [25]. In 2018, Reed et al. showed how a management method based on the Nadler-Tushman Congruence Model, a commonly used business tool, can be used to evaluate the performance

of a CCL through the lens of several elements [25]. These elements include executive leadership, strategy, critical tasks, formal organisation, people, and culture. This systematic approach is essential to instituting improvement initiatives that will lead to an efficient and, in turn, more environmentally sustainable CCL.

## Strategy 5: Monitoring and Quality Improvement

Comprehensive data and data collection systems are essential to establish baseline carbon footprint, monitor progress and evaluate effectiveness of decarbonising strategies [24]. The National Health Service (NHS) in the UK formed a Sustainable Development Unit in 2008 and commenced monitoring its carbon footprint [26]. In less than a decade, it reported reduction of emissions by 11% from 2007 to 2015 and saved the NHS GBP£1.85 billion while increasing services by 18% [27,28]. Engaging the leadership teams at our institutions to begin conversations around funding for initiatives and tools that monitor use of equipment, waste production and associated carbon emissions is necessary to ensure accountability. A tracking system would enable identification of major sources of emissions and inefficiencies which would allow more effective resource allocation in efforts to decarbonise the CCL. Data from the system should be used for quality improvement, strategy evaluation and providing objective feedback to clinical teams. Real time feedback to clinical teams on a case or list basis can result in team engagement. Real time feedback has shown to be an effective way of reducing radiation dose in the CCL [29].

## Conclusion

With millions of procedures performed worldwide, a commitment to making even small changes in everyday practice by the interventional cardiology community can lead to large environmental benefits. The COVID-19 pandemic has shown us that, with appropriate impetus, we have the ability to radically redesign services in a short period of time and make significant changes. While there may be a long way to go to decarbonise our health system and move towards zero-emission services, we hope this manuscript encourages readers to reflect on their own practice and commit to becoming a 'greener' CCL.

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## Appendices

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