

# Sustainable Healthcare: *Medical waste, Circular economy solutions*



# Executive Summary

## Context

The Australian health system generates significant amounts of Personal Protective Equipment (PPE) waste contributing to greenhouse gas emissions, plastic pollution, environmental health issues and avoidable healthcare care costs. The surge in single use PPE (masks, gowns, hats, gloves, eyewear, and face shield) waste during the COVID-19 pandemic highlighted this issue.

A circular economy approach, which involves designing waste out of the system, offers the healthcare sector a range of methods for reducing emissions and pollutants in producing, transporting and disposing of this waste, conserving resources, reducing costs and minimising waste while maintaining healthcare standards.

## Approach

Deakin University partnered with Barwon Health, a large regional health service in Victoria, to implement a study of the drivers of, and actions needed to reduce, single-use PPE waste in their Emergency Department. A collaborative research approach called Group Model Building enabled clinicians, sustainability and environmental waste managers, procurement leads, consumer representatives, policy-makers and scientists to build a shared understanding of the drivers of PPE waste in a systems map, and priority actions for implementing a circular economy transition regarding PPE.

## Findings

The discussions and resulting systems maps highlighted five key drivers of single use PPE waste:

- Procurement processes that are predominantly centralised (beyond hospital control), and do not prioritise life cycle analysis/carbon footprint, plastic waste and environmental contamination.
- While COVID-19 necessitated increased PPE use, there was a lack of clarity regarding how much PPE was required for various clinical scenarios.
- Clinical drivers such as capacity for infectious patient cohorting also impacts upon PPE use.
- Waste management processes do not currently capitalise on potentially recyclable material.
- There are barriers to clinical and environmental staff engagement in waste handling processes.

## Recommendations

Key recommendations arising centered on four priority action areas involving stakeholders at the levels of system/policy, health service and university:

- [Interpretation and practical application of infection control guidelines](#)
- [Procurement of re-useable and recyclable PPE](#)
- [Enhancing opportunities for circular economy approaches](#)
- [Sustainability and waste education and champion.](#)



## What is the issue?

The Australian healthcare system generates significant amounts of medical waste contributing to greenhouse house emissions, air and plastic pollution, environmental health issues and avoidable healthcare costs.<sup>1,2</sup> The surge in the use of personal protective equipment (PPE) (e.g. single use masks, gowns and hats) during the COVID-19 pandemic has drawn attention to the scale of environmental impacts and costs of medical waste in healthcare<sup>3</sup>.

The Global Roadmap for Healthcare Decarbonisation recommends implementing a circular economy approach to the procurement of supplies and sustainable management of healthcare waste<sup>4</sup>. A circular economy approach, which involves designing waste out of the system, offers the healthcare sector a range of methods for reducing greenhouse gas emissions and other pollutants in producing, transporting and disposing of this waste, conserving resources, reducing costs and minimising waste while maintaining healthcare standards. A circular economy approach requires an interdisciplinary, whole of supply chain approach to healthcare system redesign.

Barwon Health, a large regional health service in Victoria, identifies environmental sustainability as a strategic priority<sup>5</sup>. In 2021, Barwon Health partnered with Deakin University to identify and co-design collaborative research projects using circular economy and systems science approaches to generating solutions to sustainability challenges. Single use PPE waste was identified as a key priority and the partnership was awarded a Deakin Institute for Health Transformation seed grant with the aims of:

- Creating a shared understanding of the drivers of PPE waste in Barwon Health.
- Developing a set of practical ideas to address these drivers.
- Identifying priorities and co-design actions for implementation.

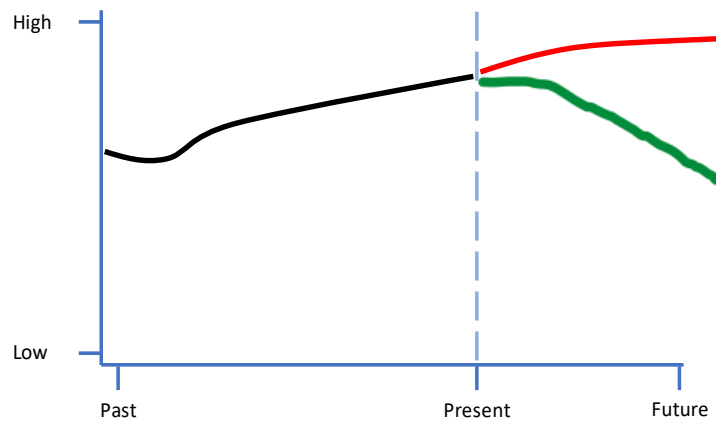
The intention of the process was to build relationships between stakeholders and understanding about their different roles and contributions to better management of single use PPE.

## What did we do?

A collaborative, systems dynamics research method called Group Model Building (GMB) over three sessions was used. GMB is ideal for situations where the aim is to build consensus between experts from different disciplines about how a complex problem works and what can be done about it. Trained facilitators guide a series of workshop activities which they simultaneously translate into a visual “map” of the problem. The map is gradually built up into a Causal Loop Diagram (Fig. 7) with a set of corresponding interventions which participants agree are feasible and will be impactful when implemented.

The Emergency Department was chosen to be the study setting as it is a department where a high volume of PPE is used, it is a central entry point for patients for the hospital admission and many of the issues relating to PPE use will be generalisable to the broader hospital and other healthcare settings.

Key stakeholders (N = 22) with expertise and experience to contribute to the topic including clinicians, sustainability manager, environmental waste management, procurement leads, administrative staff and consumer reps participated in a 3 part-series of interviews and focus group workshops. The starting point for the workshops was an evidence-based problem statement which participants agree accurately represents the situations (Fig. 1). Over time single use PPE waste has increased (past to present: black line). In the future, without intervention, the red line predicts stakeholder concerns, i.e. that single use PPE waste will continue. The green line represents hope for the future, i.e. PPE waste will decline.



**Figure 1: PPE waste in Barwon Health ED overtime – projected scenarios.**

In workshop series 1, participants identified the key drivers (or factors) affecting PPE waste, and ways in which these factors influence one another culminating in the development of a preliminary systems map using STICKE software (<https://sticke.deakin.edu.au/>).

In workshop 2 stakeholders reviewed the map, confirmed that the map and description of factors accurately reflect previous discussions, adding factors they felt were missing and confirming the logic of sub-topics (procurement, staff engagement, waste management, the impacts of COVID-19 (C19 pandemic, clinical drivers). They then annotated the map with existing actions, where action was needed and where they had power to act in the system.

In the third and final workshop, a wider group of stakeholders including policymakers, scientists, industry and peak body representatives along with Barwon Health staff and consumers spent time prioritising and co-designing actions that could be implemented. Detailed action plans including workforces, measures and resources to support implementation was generated across four priorities.

# What factors influence PPE use?

## Theme 1: Procurement

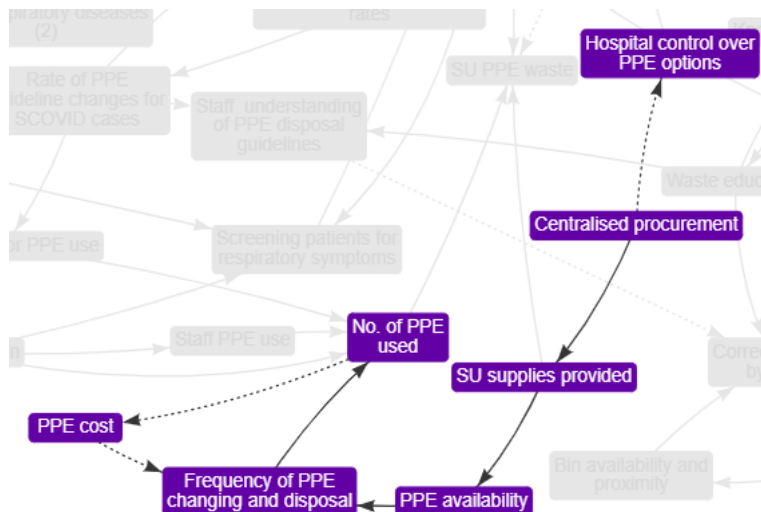


Figure 2: Procurement

This topic highlighted the influence of procurement options and decision-making in availability and use of PPE. For example, Fig.2 demonstrates with an increase in centralised procurement, hospital’s control over PPE options-including multi-use PPE- decreases (denoted by dotted line, an inverse relationship). On the other hand, the competitive advantage of increased centralised procurement leads to an increase in Single Use PPE supplies. (Denoted by solid black which represents a mutually reinforcing relationship). The perception of abundant supplies increases the frequency of PPE changing and disposal. Whereas an increase in PPE costs decreases the frequency of PPE changing and disposal and reduces the number of PPE used (representing a feedback loop in the system). Staff make these PPE utilisation decisions based on many other factors, as exemplified below.

## Theme 2: COVID -19 Pandemic

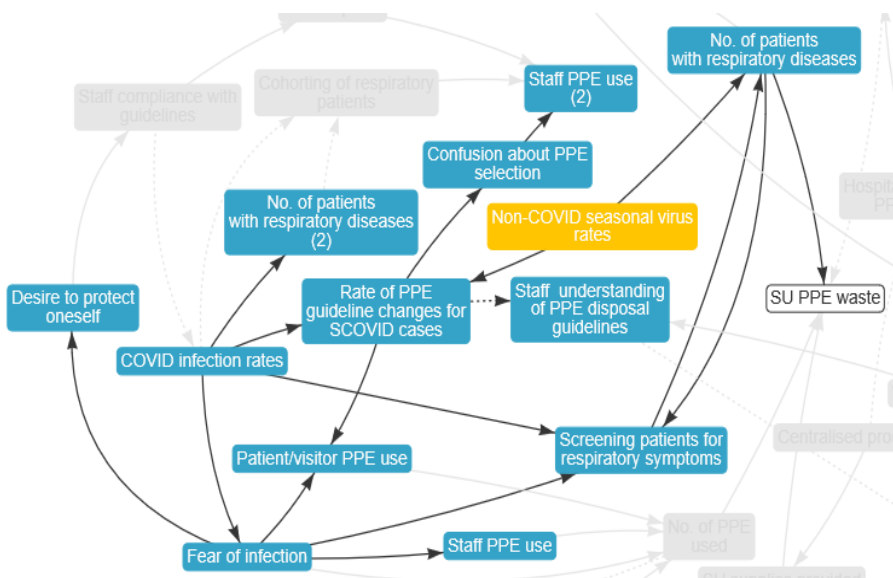


Figure 3: COVID Pandemic

This topic highlighted the drivers of PPE use arising from the COVID-19 pandemic. For example, fear of infection increases with the increase in COVID rates. This fear of infection leads to increased use of PPE by staff and patients/visitors. Similarly, as COVID-19

infection rates increased, so did the rate of PPE guideline changes for Suspected c-19 (SCOVID) cases. This increased confusion about PPE selection which increased PPE use (as staff, patients and visitors tend to default to cautionary PPE use when uncertain- e.g. if unsure if gowns and gloves are required as per the guidelines, staff will more likely default to donning, particularly when fear of infection is high).

### Theme 3: Clinical drivers

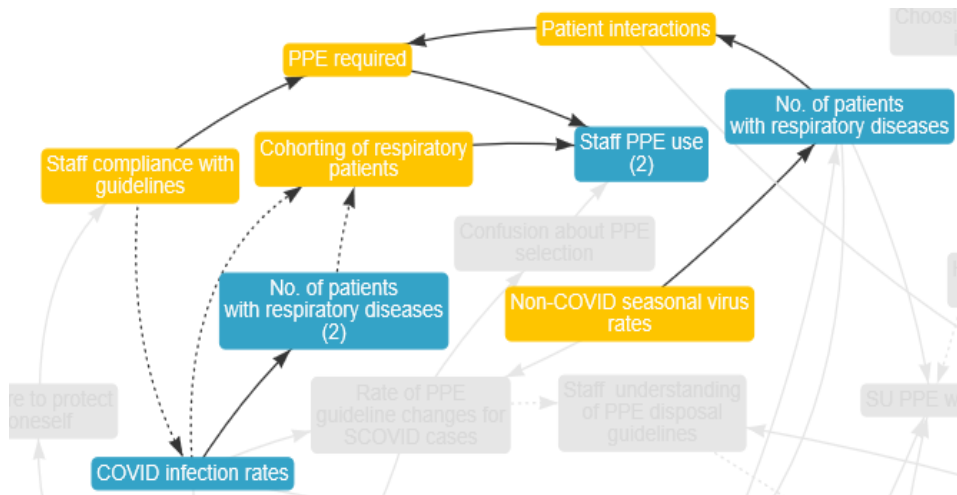


Figure 4: Clinical drivers

The pandemic impacted other clinical drivers. With the increase in patients presenting with SCOVID respiratory diseases, the unit’s capacity to cohort these respiratory patients to COVID and non-COVID areas may decrease. This increases staff PPE use as donning and doffing is required for every patient interaction rather than staff in a designated COVID area leaving their PPE on for the shift.

### Theme 4: Waste management

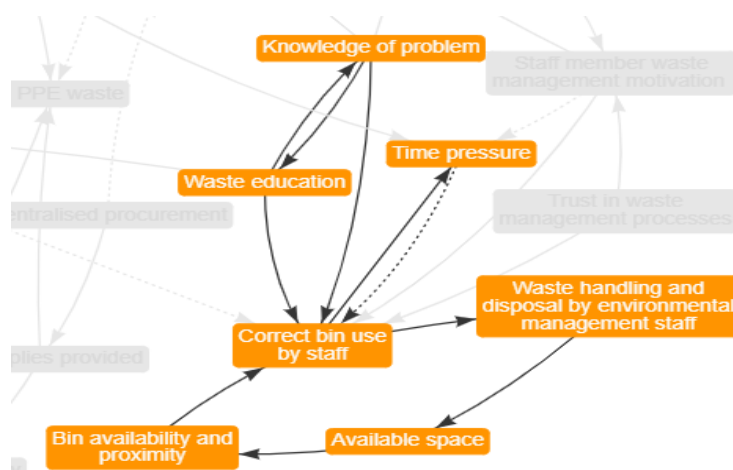


Figure 5: Waste management

This topic highlighted waste management issues. When there is an increased amount of available space in the department, bin availability and proximity may also increase. This leads to correct bin use by staff. When the correct bins are being used, there will be an increase in proper waste handling and disposal by environmental management staff. However, time pressures in a busy ED can decrease bin use. Conversely correct bin use may increase time pressures. Waste education increase knowledge of waste management and vice versa.

## Theme 5: Staff engagement

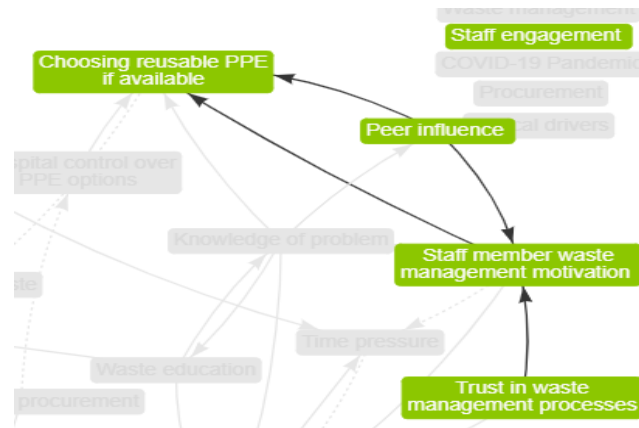


Figure 6: Staff engagement

The topic of staff engagement was highlighted and linked to waste management. For example, an increase in staff knowledge of the problem can increase waste management motivation, peer influence, and trust in waste management processes. When the trust in waste management processes increases, correct bin use by staff also increases. Additionally, an increase in peer influence can increase staff member waste management outcomes.

These five theme areas make up the entire system or Casual Loop Diagram (Fig. 7) and link to the four priority action areas identified by the health sector stakeholders involved in the consultation process.

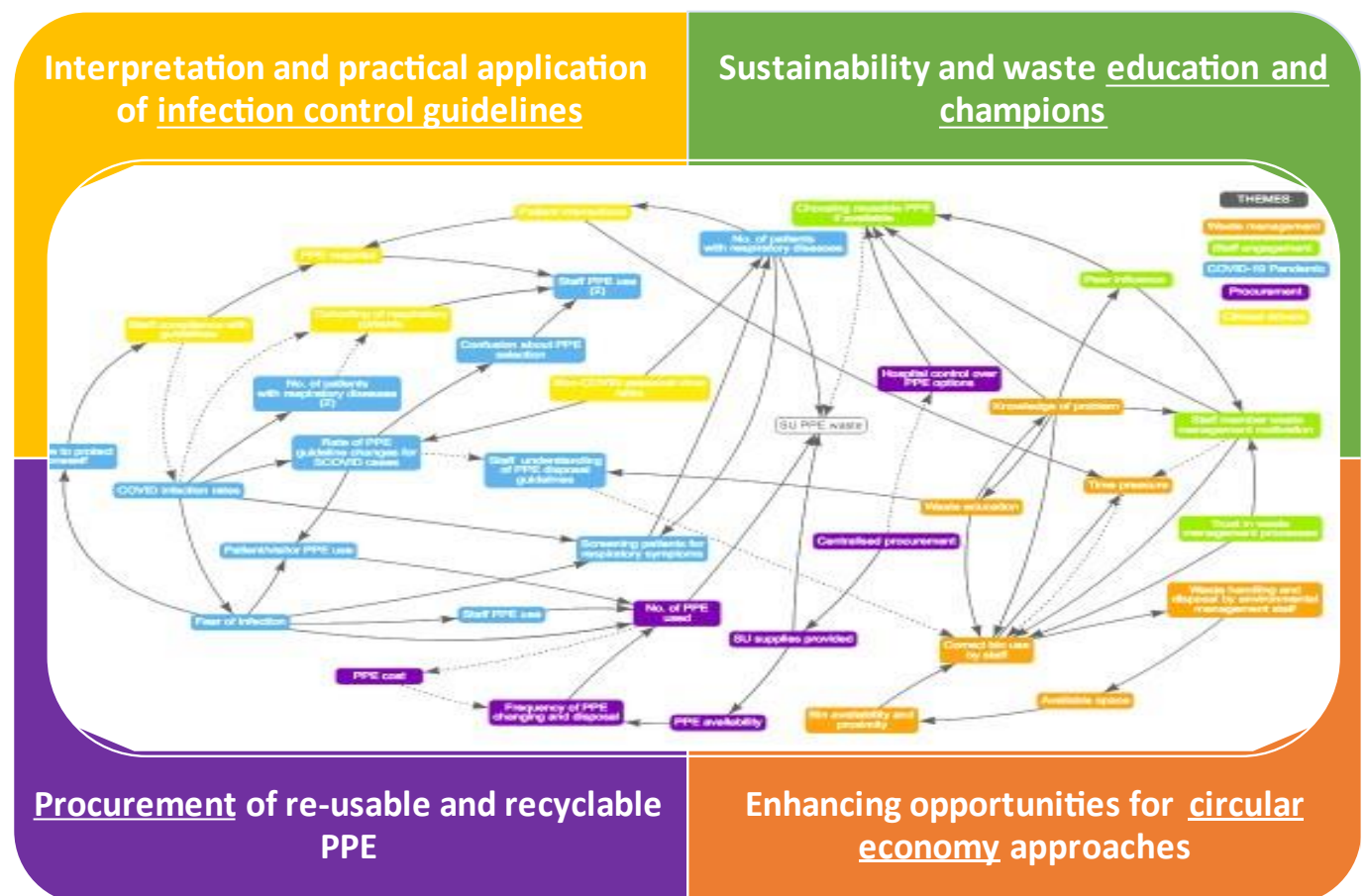


Figure 7: Full systems map linked to priority actions.

# What actions do health sector stakeholders suggest?

(For details, please see link to [Table-1 Sustainable PPE Short Report](#))

## Interpretation and practical application of infection control guidelines

### System and Policy level

- Update state guidance to clarify:
  - Minimum PPE for various scenarios.
  - Washable/re-usable PPE are acceptable in most clinical interactions.
  - Need for waterproof gowns (and [AAMI rating](#)) vs. apron.
- State government implement a glove use reduction campaign (such as [Gloves are Off](#), NHS UK)

Enhanced state guideline clarity regarding minimum PPE requirements is likely to lead to reductions in PPE (gloves, gowns and masks) use across the health sector.

### Health Service level

- Update PPE and infection control guidance to ensure it correlates with state guidance.
- Link updated PPE guidance from infection prevention team to staff education.
- Education and updated guidance:
  - Supports staff to don only the PPE required for evidence-based infection prevention.
  - Clarifies specific PPE requirement for various clinical situations.
- Appoint PPE working group within Environmental Sustainability Committee (ESC).
- Consider factors enabling patient cohorting at entry to Emergency Department including earlier Qiagen viral testing.

### University level

- Partner university liaises with state Dept of Health and health organisation infection prevention teams to:
  - Confirm washable gowns meet infection prevention standards.
  - Clarify guidelines re minimum PPE for various scenarios.
  - Make recommendations regarding PPE supply chains and waste circular economy opportunities e.g. [Net zero supplier roadmap](#).

## Procurement of re-useable and recyclable PPE

### System and Policy level

- State health department update PPE guidelines to include carbon footprint/life cycle analysis of PPE to guide procurement decisions.
- Establish a state Sustainable Healthcare Unit (SHU) which:
  - Sets procurement decarbonisation targets and timelines (as per NHS- UK).
  - Facilitates state procurement lead (e.g. HealthShare Victoria) embedding LCA into all procurement guidelines and contract negotiations with suppliers.
  - Supports health services in negotiating procurement autonomy.
- Health service and University partner makes recommendations to SHU and state procurement lead to set targets and contractual expectation for health products to have:
  - Environmental Product Declarations.
  - End of life disposal plans.

### Health Service level

- Negotiate with state departments for greater autonomy over contextually relevant PPE procurement decisions,
- Appoint procurement leads to ESC.
- Ensure hospital procurement decisions are informed by balancing clinical requirements, LCA/carbon footprint data, financial analysis and circular economy principles.



- Professional development of environmental sustainability committee and procurement leads ensure optimal procurement decisions across a range of parameters.

#### **University level**

- Partner university to undertake a cost-benefit analysis of PPE options. For example, single use vs re-useable PPE gown cost-benefit analysis at health service level.
- University partner share implementation evidence with health service and state level departments to guide decision-making.
- Where cost-benefit analysis favorable, University and health service partner to implement a trial in Emergency Department, e.g. washable gown trial.

## **Enhancing opportunities for circular economy approaches**

#### **State and policy level**

- Establish SHU and partner with universities to generate circular economy evidence-base and guidance.
- State health department clarify guidance and implement a campaign to increase health service awareness regarding PPE waste disposal. For example:
  - Differentiating between general, clinical, and recyclable waste streams.
  - PPE may be disposed of in general waste rather than clinical waste unless soiled with bodily fluids.

#### **Health Service level**

- Health service to appoint circular economy project group within Environmental Sustainability Committee
- Future builds require extra space allocation for waste station sorting in clinical areas and waste sorting prior to transport.
- Improve waste bin systems to support better identification and disposal of general/clinical/recyclable waste at each station.
- Enhance health service capacity for onsite washing and autoclaving of re-usable PPE.
- Health service to consider compositable gloves trial in Emergency Department.

#### **University level**

- University's partner with state health department (or SHU) to provide academic expertise on circular economy.
- Implement a medical waste circular economy materials science research program. Example projects identified:
  - uncontaminated single use polypropylene gowns to re-useable polypropylene composite gowns and scrubs.
  - Compostable aprons from cellulose.

## **Sustainability and waste education and champions**

#### **Systems and policy level**

- State health department could:
  - clarify state waste guidance,
  - foster circular economy industry partnerships, and
  - increase health service awareness of PPE waste disposal.

#### **Health Service level**

- Appoint sustainability education and waste leaders in Environmental Sustainability Committee.
- Organisational assessment of PPE waste prevention and recycling opportunities amidst existing pressures
- Show and track what waste can be recycled.
- Foster sustainability champions and mentors who will lead waste and recycling initiatives including social media engagement initiatives.
- Develop health service waste handling guidelines which:
  - are simple but support appropriate behavior.
  - incentivise and encourage improvements.
- Bin decision support for staff -e.g. posters at waste handling sites.
- Provide feedback and emphasise positive behaviors across all staff groups.
- Implement tangible and waste wins with recyclable products, e.g. revamp of PVC recycling.

#### **University level**

- Universities work with Department and Health service regarding identification of potentially high value recyclable waste.
- Trial circular economy recycling scheme, e.g. unsoiled single use gowns converted to new reusable gowns.

This system focused on a group model building project leveraged the opportunity of a University - Hospital sustainability research partnership.

By harvesting action ideas from a motivated group of hospital and broader stakeholder experts, we have mapped out an approach to co-creating a system-oriented waste reduction response.

There are many calls for methods to reduce clinical waste. This case study, in a hospital ED, is one of the few that presents practical responses across the system.

The researchers are most grateful to our hospital partner for authorizing this work and for the time and input of all participants. We extend our particular thanks to the state Department of Health leads who have taken some of these recommendations, regarding guideline clarity and circular-economy PPE procurement planning, back to the relevant working groups for further consideration.

## Contact details

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## References

1. Malik A, Lenzen M, McAlister S, McGain F (2018) The carbon footprint of Australian health care. *Lancet Planet Health*. Jan;2(1):e27-e35. doi: 10.1016/S2542-5196(17)30180-8.
2. Beale R, Patrick R, Forrester M (2022) Decarbonising our healthcare, a prescription for action. Podcast. Available at: <https://iht.deakin.edu.au/podcasts/decarbonising-our-healthcare-a-prescription-for-action/>
3. Rizan C, Reed M, Bhutta M. (2021) Environmental impact of personal protective equipment distributed for use by health and social care services in England in the first six months of the COVID-19 pandemic. *Journal of the Royal Society of Medicine*. 2021. 114(5):250-263. Sustainability Victoria. Waste education in healthcare. Available at: <https://www.sustainability.vic.gov.au/about-us/our-mission/our-strategies/waste-education-in-healthcare>
4. HCWH. Global Road Map for Health Care Decarbonization. Chapter 5, Charting a course: toward zero emissions health care, 55- 86. Health Care Without Harm. 2021. Available at: <https://healthcareclimateaction.org/sites/default/files/2021-04/HCWH%20Road%20Map%20for%20Health%20Care%20Decarbonization%20-%20Chapter%205.pdf>
5. Barwon Health (2020) Future Ready, Barwon Health Strategic Plan 2020-2025 . Available at: [https://www.barwonhealth.org.au/images/documents/11295\\_StrategicPlan2020-25\\_vFINAL\\_-\\_Copy.pdf](https://www.barwonhealth.org.au/images/documents/11295_StrategicPlan2020-25_vFINAL_-_Copy.pdf)