

## Introduction and Background

Operating rooms (ORs) are areas of a hospital where life-saving surgical procedures are performed. The OR also presents a unique challenge for sustainability, since it produces up to a third of a hospital's waste, uses the most energy per square foot, and demands a large proportion of the hospital's medical supplies.<sup>1</sup> Since the current state of the climate crisis represents the most prolonged threat to global health, managing the environmental impact of ORs is crucial and time-sensitive.

## Research Objective and Questions

The objective of this research is to describe the relevance and urgency of sustainability initiatives in the OR.

The research questions are:

- (1) What efforts/tools currently exist to address the environmental impact of hospital ORs?
- (2) What is the current state of OR sustainability efforts in 14 academic hospital systems in the GTA?
- (3) What are the current barriers and challenges that hospitals experience in implementing sustainability strategies in the OR?

## Methodology

### Literature Review Methods

- Identified the main environmental harms of ORs, using Web of Science, University of Toronto Library Search, PubMed, and Google Scholar databases
- Analyzed the features of scorecards, checklists, and related tools that reduce OR environmental impact
- Accessed the gaps in the tools published by Canadian Coalition of Green Health Care, Greening Health Care, Pan American Health Organization, American Society of Anesthesiologists, and Practice Greenhealth

### Interview and Scorecard Development Methods

- Conducted interviews over Microsoft Teams with key stakeholders in the OR: surgeons, OR nurses, facilities managers, and leadership team members
- Created a scorecard that compares hospital practices to each other to encourage change and improved sustainability management

## Results: Literature Review

The main contributors to the carbon footprint of ORs are the emissions of anesthetic gases, the medical devices and materials used, the associated waste of these materials, and the energy consumption from lighting and heating, ventilation, and air conditioning (HVAC) systems.<sup>2,3</sup>

The grey literature contains toolkits, checklists, and other benchmarking tools to address these issues. The only relevant scorecard in Canada is the Green Hospital Scorecard, developed by the Canadian Coalition for Green Healthcare, which only broadly summarizes sustainable solutions for Canada's health care system.<sup>4</sup>

## Results: Scorecard Sustainability Recommendations

The following scorecard was created by the Sustainable Operating Room Initiative Team as a result of a year-long iterative process. The goal of the scorecard is to encourage change that is in alignment with the most sustainable strategies for OR care. The recommendations are based on academic literature and professional opinion.

## Sustainable Operating Rooms Score Card

Grading Scheme	
Green	Achieves the sustainability strategy
Orange	In the process of achieving/partially achieves the sustainability strategy
Red	Does not achieve the sustainability strategy
Purple	We are unsure/do not have enough data from the hospital/Not applicable

ENERGY MANAGEMENT	
Sustainability Strategy	How to be More Sustainable
Reduce energy consumption from HVAC systems	<ul style="list-style-type: none"> <li>Implement at least two of the orange recommendations</li> <li>Create an HVAC timers/setback system</li> <li>Create an operating room heating and cooling system separate from the general hospital's system</li> <li>Create a heat reclamation system</li> </ul>
Reduce energy use from operating room lights	<ul style="list-style-type: none"> <li>Convert all surgical and overhead lights in every operating room to LED</li> <li>Surgical lights are a mixture of LED and non-energy efficient</li> <li>Overhead ceiling lights are a mixture of LED and non-energy efficient</li> <li>Create an automated lighting control system</li> </ul>

REUSABLES	
Sustainability Strategy	How to be More Sustainable
Extend use of disposable - anesthesia breathing circuits	<ul style="list-style-type: none"> <li>Extend the use of breathing circuits for 24 hours or even up to a week</li> <li>Educate staff on the environmental impacts of disposing breathing circuits after every case</li> </ul>
Reusable laryngeal mask airways (LMAs)	<ul style="list-style-type: none"> <li>When LMAs are appropriate to the patient, exclusively use reusable ones</li> <li>Have reusable LMAs available in the hospital</li> <li>Educate staff on the environmental impacts of disposable LMAs</li> </ul>
Reusable linens (Sterile surgical gowns)	<ul style="list-style-type: none"> <li>Only have disposable gowns available for those that need them due to their size</li> <li>Remove disposable gowns from custom packs</li> <li>Do not keep disposable gowns in the sterile core</li> </ul>

The hospital scores were removed to respect privacy and confidentiality commitments.

ANESTHETIC GASES	
Sustainability Strategy	How to be More Sustainable
Avoid desflurane for surgical procedures requiring general anesthesia to encourage the use of more environmentally friendly gases like sevoflurane	<ul style="list-style-type: none"> <li>Remove desflurane from the hospital's formulary</li> <li>A formal program is in place to discourage the use of desflurane, e.g.,               <ul style="list-style-type: none"> <li>Lock desflurane vaporizers away</li> <li>Keep desflurane in pharmacy</li> <li>Formal continuous education on using environmentally friendly gases</li> </ul> </li> </ul>
Use ≤0.5L/min fresh gas flow	<ul style="list-style-type: none"> <li>Educational/ engagement program in place to encourage the use of fresh gas flow of ≤0.5L/min</li> <li>Acquisition of anesthetic gas machines that give ≤0.5L/min fresh gas flow as a default</li> <li>Existing anesthetic machines are modified so they can deliver a minimum fresh gas flows ≤0.5L/min</li> </ul>

WASTE MANAGEMENT	
Sustainability Strategy	How to be More Sustainable
Accurate hazardous waste segregation - minimizing the biohazardous waste stream (i.e., sharps, cytotoxic, and regular biohazardous)	<ul style="list-style-type: none"> <li>Develop a team dedicated to education/informing strategies that minimize biohazardous waste and ensure they are accurately disposed of AND perform waste monitoring (waste weight audits/visual waste audits)</li> <li>Develop a team dedicated to education/informing strategies that minimize biohazardous waste and ensure they are accurately disposed</li> </ul>
Develop and implement an effective waste reduction/recycling program in the OR	<ul style="list-style-type: none"> <li>Operating room specific recycling program in place supported by a team dedicated to education/ informing AND perform specialty recycling (e.g., diverting single-use items to be remanufactured, PVC 123 program, blue sterile wrap recycling)</li> <li>Develop a team dedicated to education/informing strategies that encourage effective recycling</li> </ul>
Reduce waste by using specialized custom packs with procedure-specific supplies	<ul style="list-style-type: none"> <li>Have a team that monitors custom packs periodically to ensure that they only contain the bare minimum</li> <li>Create procedure specific custom packs that contain procedure specific supplies</li> </ul>

## Discussion

- Calls for environmental action in the OR community are abundant in recent years with regards to greener anesthetic gas options, waste, medical supplies management, and energy management
- The existing literature surrounding OR sustainability lacks a comprehensive review of the available tools, what they offer, where they are lacking, and what barriers must be overcome
- This research confirms that there is no available scorecard in Canada to drive sustainable improvement in the OR specifically
- The novel scorecard is a level-setting device
  - It allows hospital leaders to compare their institutions to others that have better scores
  - Comparative data hopes to work as a forcing function to invoke action (based on a Community of Practice change model)

## Next Steps and Conclusion

- Anesthetic gas use, supplies, waste, and energy are the main areas that must be addressed to improve the environmental sustainability of ORs
- The main barriers to implementing OR sustainability programs are cost, absence of a green team, culture, safety and sanitation of greener alternatives, and infrastructure and technological limitations
- Rather than conducting more studies on the OR's impact on the environment, solutions to the barriers should be engaged with
- Future research should surround areas of current uncertainty regarding sustainability strategies
- Action that is systematic in nature and focuses on sharing the gold standard across hospital networks will improve the wellbeing of current and future generations

## References

- Watts, N., Amann, M., Ayeb-Karlsson, S., Belesova, K., Bouley, T., Boykoff, M., Byass, P., Cai, W., Campbell-Lendrum, D., Chambers, J., Cox, P. M., Daly, M., Dasandi, N., Davies, M., Depledge, M., Depoux, A., Dominguez-Salas, P., Drummond, P., Ekins, P., ... Costello, A. (2018). The Lancet Countdown on health and climate change: From 25 years of inaction to a global transformation for public health. *Lancet (London, England)*, 391(10120), 581-630. [https://doi.org/10.1016/S0140-6736\(17\)32464-9](https://doi.org/10.1016/S0140-6736(17)32464-9)
- Friederich, H. J., Sperna Weiland, N. H., van der Eijk, A. C., & Jansen, F. W. (2019). [Steps for reducing the carbon footprint of the operating room]. *Nederlands Tijdschrift Voor Geneeskunde*, 163, D4095.
- Wyssusek, K. H., Keys, M. T., & van Zundert, A. A. J. (2019). Operating room greening initiatives - the old, the new, and the way forward: A narrative review. *Waste Management & Research: The Journal of the International Solid Wastes and Public Cleansing Association, ISWA*, 37(1), 3-19. <https://doi.org/10.1177/0734242X18793937>
- Canadian Coalition for Green Health Care. (2019). *Green Hospital Scorecard*. <https://greenhealthcare.ca/wp-content/uploads/2021/07/2019-Green-Hospital-Scorecard-Report.pdf>