Addressing OR sustainability: How we can decrease waste and emissions

Studies have shown that carbon emissions from hysterectomy procedures can be reduced by 80%. The authors detail how, and recommend a 30-day climate challenge.

Kelly N. Wright, MD; Kaia M. Schwartz, MD

In 2009, the *Lancet* called climate change the biggest global health threat of the 21st century, the effects of which will be experienced in our lifetimes.[1] Significant amounts of data have demonstrated the negative health effects of heat, air pollution, and exposure to toxic substances.[2,3] These effects have been seen in every geographic region of the United States, and in multiple organ systems and specialties, including obstetrics, pediatrics, and even cardiopulmonary and bariatric surgery.[2-5]

Although it does not receive the scrutiny of other industries, the global health care industry accounts for almost double the amount of carbon emissions as global aviation, and the United States accounts for 27% of this footprint despite only having 4% of the world's population.[6] It therefore serves that our own industry is an excellent target for reducing the carbon emissions that contribute to climate change. Consider the climate impact of hysterectomy, the second-most common surgery that women undergo. In this article, we will use the example of a 50-year-old woman with fibroids who plans to undergo definitive treatment via total laparoscopic hysterectomy (TLH).

Dr. Wright is the Director of the Division of Minimally Invasive Gynecologic Surgery and Associate Professor, Department of Obstetrics and Gynecology, Cedars-Sinai Medical Center, Los Angeles, California

Dr. Schwartz is a fourth-year resident in the OB/GYN & Women's Health Institute, Department of Obstetrics and Gynecology, Cleveland Clinic Foundation, Cleveland, Ohio

Dr. Wright reports being a consultant for Aqua Therapeutics, Ethicon, Hologic, and Karl Storz. Dr. Schwartz reports no conflicts of interest.

doi: 10.12788/obgm.0260

Climate impact of US health care

Hospital buildings in the United States are energy intensive, consuming 10% of the energy used in commercial buildings every year, accounting for over $8 billion. Operating rooms (ORs) account for a third of this usage.[7] Hospitals also use more water than any other type of commercial building, for necessary actions like cooling, sterilization, and laundry.[8] Further, US hospitals generate 14,000 tons of waste per day, with a third of this coming from the ORs. Sadly, up to 15% is food waste, as we are not very good about selecting and proportioning healthy food for our staff and inpatients.[6]

IN THIS ARTICLE

CONTINUED ON PAGE 28

CONTINUED FROM PAGE 27

TABLE Highest impact areas to reduce the carbon footprint in gynecologic surgery

- Minimize single-use devices and opened materials
- Avoid the use of volatile anesthetic gases
- Maximize instrument reuse and single-use device reprocessing
- Reduce off-hour energy use in the operating room
- Reduce regulated medical waste to less than 10% of total waste stream

While health care is utility intensive, the majority of emissions are created through the production, transport, and disposal of goods coming through our supply chain.[6] Hospitals are significant consumers of single-use objects, the majority of which are petroleum-derived plastics—accounting for an estimated 71% of emissions coming from the health care sector. Supply chain is the second largest expense in health care, but with current shortages, it is estimated to overtake labor costs by this year. The United States is also the largest consumer of pharmaceuticals worldwide, supporting a $20 billion packaging industry,[9] which creates a significant amount of waste.

Climate impact of the OR

Although ORs only account for a small portion of hospital square footage, they account for a significant amount of health care's carbon footprint through high waste production and excessive consumption of single-use items. Just one surgical procedure in a hospital is estimated to produce about the same amount of waste as a typical family of 4 would in an entire week.[10] Furthermore, the majority of these single-use items, including sterile packaging, are sorted inappropriately as regulated medical waste (RMW, "biohazardous" or "red bag" waste) (**FIGURE 1A**). RMW has significant effects on the environment since it must be incinerated or steam autoclaved prior to transport to the landfill, leading to high amounts of air pollution and energy usage.

FIGURE 1

Inappropriately sorted waste into biohazardous bags. Operating room packaging is not only clean but often sterile and should be recycled or triaged into regular waste.

An overreliance on biohazardous bags in the operating room results in high amounts of regulated medical waste in the waste stream, leading to increased cost and carbon emissions.

We all notice the visible impacts of waste in the OR, but other contributors to carbon emissions are invisible. Energy consumption is a huge contributor to the overall carbon footprint of surgery. Heating, ventilation, and air conditioning [HVAC] is responsible for 52% of hospital energy needs but accounts for 99% of OR energy consumption.[11] Despite the large energy requirements of the ORs, they are largely unoccupied in the evenings and on weekends, and thermostats are not adjusted accordingly.

Anesthetic gases are another powerful contributor to greenhouse gas emissions from the OR. Anesthetic gases alone contribute about 25% of the overall carbon footprint of the OR, and US health care emits 660,000 tons of carbon equivalents from anesthetic gas use per year.[12] Desflurane is 1,600 times more potent than carbon dioxide (CO_2) in its global warming potential followed by isoflurane and sevoflurane;[13] this underscores the importance of working with our anesthesia colleagues on the differences between the anesthetic gases they use. Enhanced recovery after surgery recommendations in gynecology already recommend avoiding the use of volatile anesthetic gases in favor of propofol to reduce postoperative nausea and vomiting.[14]

In the context of a patient undergoing a TLH, the estimated carbon footprint in the United States is about 560 kg of CO_2 equivalents—roughly the same as driving 1,563 miles in a gas-powered car.

Climate impact on our patients

The data in obstetrics and gynecology is clear that climate change is affecting patient outcomes, both globally and in our own country. A systematic review of 32 million births found that air pollution and heat exposure were associated with preterm birth and low birth weight, and these effects were seen in all geographic regions across the United States.[1] A study of 5.9 million births in California found that patients who lived near coal- and oil-power plants had up to a 27% reduction in preterm births when those power plants closed and air pollution decreased.[15] A study in *Nature Sustainability* on 250,000 pregnancies that ended in missed abortions at 14 weeks or less found the odds ratio of missed abortion increased with the cumulative exposure to air pollution.[16] When air pollution was examined in comparison to other factors, neighborhood air pollution better predicted preterm birth, very preterm birth, and small for gestational age more than race, ethnicity, or any other socioeconomic factor.[17] The effects of air pollution have been demonstrated in other fields as well, including increased mortality after cardiac transplantation with exposure to air pollution,[4] and for patients undergoing bariatric surgery who live near major roadways, decreased weight loss, less improvement in hemoglobin A_{1c}, and less change in lipids compared with those with less exposure to roadway pollution.[5]

Air pollution and heat are not the only factors that influence health. Endocrine disrupting chemicals (EDCs) and single-use plastic polymers, which are used in significant supply in US health care, have been found in human blood,[18] intestine, and all portions of the placenta.[19] Phthalates, an EDC found in medical use plastics and medications to control delivery, have been associated with increasing fibroid burden in patients undergoing hysterectomy and myomectomy.[20] The example case patient with fibroids undergoing TLH may have had her condition worsened by exposure to phthalates.

Just **one surgical procedure** in a hospital is estimated to produce about the **same amount of waste as a typical family of 4 would in an entire week**

FAST TRACK

A study of 5.9 million births in California found that patients who lived near coal- and oil-power plants had up to a 27% reduction in preterm births when those power plants closed and air pollution decreased

CONTINUED ON PAGE 30

CONTINUED FROM PAGE 29

Specific areas for improvement

There is a huge opportunity for improvement to reduce the total carbon footprint of a TLH.

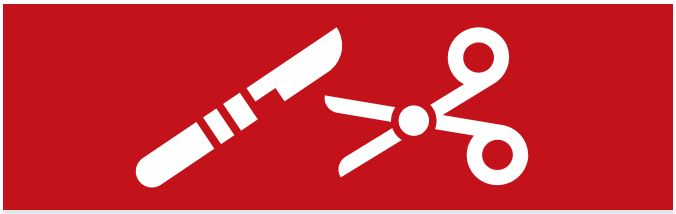
A lifecycle assessment of hysterectomy in the United States concluded that an 80% reduction in carbon emissions could be achieved by minimizing opened materials, using reusable and reprocessed instruments, reducing off-hour energy use in the OR (HVAC setbacks), and avoiding the use of volatile anesthetic gases.[21] The sterilization and re-processing of reusable instruments represented the smallest proportion of carbon emissions from a TLH. Data on patient safety supports these interventions, as current practices have more to do with hospital culture and processes than evidence.

Despite a push to use single-use objects by industry and regulatory agencies in the name of patient safety, data demonstrate that single-use objects are in actuality *not* safer for patients and may be associated with increased surgical site infections (SSIs). A study from a cancer center in California found that when single-use head covers, shoe covers, and facemasks were eliminated due to supply shortages during the pandemic, SSIs went down by half, despite an increase in surgical volume and an increase in the number of contaminated cases.[22] The authors reported an increase in hand hygiene throughout the hospital, which likely contributed to the success of reducing SSIs.

Similarly, a systematic review found no evidence to support single-use instruments over reusable or reprocessed instruments when considering instrument function, ease of use, patient safety, SSIs, or long-term patient outcomes.[23] While it may be easy for regulatory agencies to focus on disposing objects as paramount to reducing infections, the Centers for Disease Control and Prevention states that the biggest factors affecting SSIs are appropriate use of prophylactic antibiotics, skin antisepsis, and patient metabolic control.[24] Disposing of single-use objects in the name of patient safety will worsen patient health outcomes when considering patient proximity to waste, pollution, and EDCs.

The sterilization process for reusable items is often called out by the medical supply industry as wasteful and energy intensive; however, data refute these claims. A Swedish study researching reusable versus single-use trocars found that a reusable trocar system offers a robust opportunity to reduce both the environmental and financial costs for laparoscopic surgery.[25] We can further decrease the environmental impact of reusable instruments by using sets instead of individually packed instruments and packing autoclaves more efficiently. By using rigid sterilization containers, there was an 85% reduction in carbon footprint as compared with the blue wrap system.

Electricity use can be easily reduced across all surgical spaces by performing HVAC setbacks during low occupancy times of day. On nights and weekends, when there are very few surgical cases occurring, one study found that by decreasing the ventilation rate, turning off lights, and performing the minimum temperature control in unused ORs, electricity use was cut in half.[11]

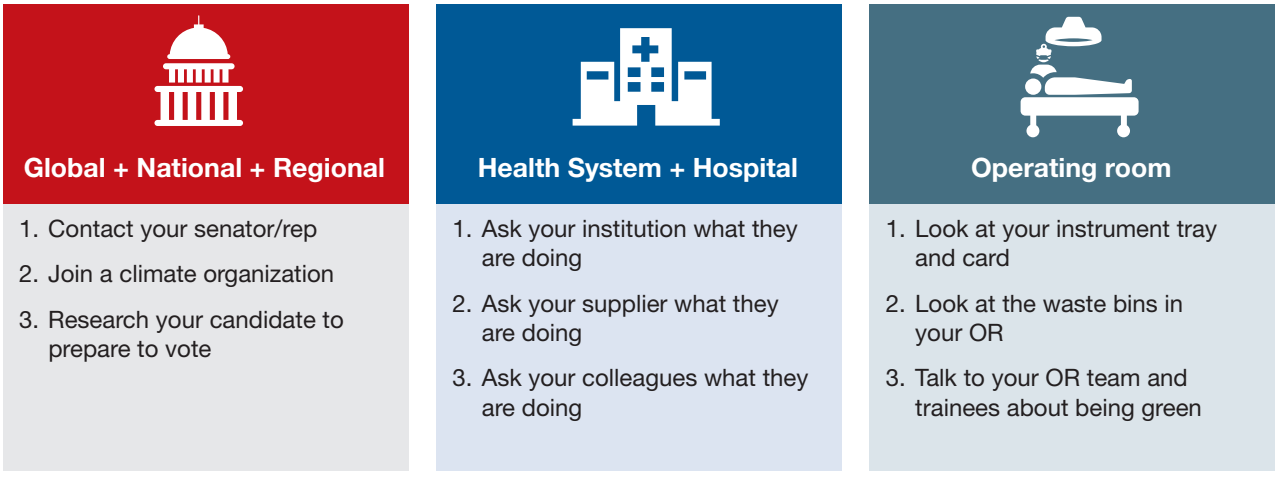


Data demonstrate that **single-use objects** are in actuality **not safer for patients** and may be associated with **increased surgical site infections**

Waste triage and recycling

Reducing regulated medical waste is another area where hospitals can make a huge impact on carbon emissions and costs with little more than education and process change. Guidelines for regulated medical waste sorting developed out of the HIV epidemic due to the fear of blood products. Although studies show that regulated medical waste is not more infectious than household waste, state

FIGURE 2 30-day climate challenge



departments of public health have kept these guidelines in place for sorting fluid blood and tissue into RMW containers and bags.[26] The best hospital performers keep RMW below 10% of the total waste stream, while many ORs send close to 100% of their waste as RMW (**FIGURE 1B**). ORs can work with nursing and environmental services staff to assess processes and divert waste into recycling and regular waste. Many OR staff are acutely aware of the huge amount of waste produced and want to make a positive impact. Success in this small area often builds momentum to tackle harder sustainability practices throughout the hospital.

Removal of EDCs from medical products

Single-use medical supplies are not only wasteful but also contain harmful EDCs, such as phthalates, bisphenol A (BPA), parabens, perfluoroalkyl substances, and triclosan. Phthalates, for example, account for 30% to 40% of the weight of medical-use plastics, and parabens are ubiquitously found in ultrasound gel.[3] Studies looking at exposure to EDCs within the neonatal intensive care unit reveal substantial BPA, phthalate, and paraben levels within biologic samples from premature infants, thought to be above toxicity limits. While we do not know the full extent to which EDCs can affect neonatal development, there is already mounting evidence that EDCs are associated with endocrine, metabolic, and neurodevelopmental disorders throughout our lifespan.[3]

30-day climate challenge

Although the example case patient undergoing TLH for fibroids will never need care for her fibroids again, the climate impact of her time in the OR represents the most carbon-intensive care she will ever need. Surgery as practiced in the United States today is unsustainable.

In 2021, the Biden administration issued an executive order requiring all federal facilities, including health care facilities and hospitals, to be carbon neutral by 2035. In order to make meaningful changes industry-wide, we should be petitioning lawmakers for stricter environmental regulations in health care, similar to regulations in the manufacturing and airline industries. We recommend a 30-day climate challenge (**FIGURE 2**) for bringing awareness to your circles of influence. Physicians have an ethical duty to advocate for change at the local, regional, and national level if we want to see a better future for our patients, their children, and even ourselves. Organizations such as Practice Greenhealth, Health Care without Harm, and Citizens' Climate Lobby can help amplify our voices to reach the right people to implement sweeping policy changes. ●

FAST TRACK

In 2021, the Biden administration issued an executive order requiring all federal facilities, including health care facilities and hospitals, to be carbon neutral by 2035

CONTINUED ON PAGE 32

CONTINUED FROM PAGE 31

References

1. Costello A, Abbas M, Allen et al. Managing the health effects of climate change: Lancet and University College London Institute for Global Health Commission. Lancet. 2009;373:1693-1733. doi: 10.1016/S0140-6736(09)60935-1.
2. Bekkar B, Pacheco S, Basu R, et al. Association of air pollution and heat exposure with preterm birth, low birth weight, and stillbirth in the US: a systematic review. *JAMA Netw Open*. 2020;3. doi:10.1001/JAMANETWORKOPEN.2020.8243.
3. Genco M, Anderson-Shaw L, Sargis RM. Unwitting accomplices: endocrine disruptors confounding clinical care. *J Clin Endocrinol Metab*. 2020;105:e3822–7. doi: 10.1210/cline2. m/dgaa358.
4. Al-Kindi SG, Sarode A, Zullo M, et al. Ambient air pollution and mortality after cardiac transplantation. *J Am Coll Cardiol*. 2019;74:3026-3035. doi: 10.1016/j.jacc.2019.09.066.
5. Ghosh R, Gauderman WJ, Minor H, et al. Air pollution, weight loss and metabolic benefits of bariatric surgery: a potential model for study of metabolic effects of environmental exposures. *Pediatr Obes*. 2018;13:312-320. doi: 10.1111/ijpo.12210.
6. Health Care's Climate Footprint. Health care without harm climate-smart health care series, Green Paper Number one. September 2019. https://www.noharm.org/ClimateFootprintReport. Accessed December 11, 2022.
7. Healthcare Energy End-Use Monitoring. US Department of Energy. https://www.energy.gov/eere/buildings/downloads/healthcare-energy-end-use-monitoring. Accessed December 11, 2022.
8. 2012 Commercial Buildings Energy Consumption Survey: Water Consumption in Large Buildings Summary. U.S Energy Information Administration. https://www.eia.gov/consumption/commercial/reports/2012/water. Accessed December 11, 2022.
9. Belkhir L, Elmeligi A. Carbon footprint of the global pharmaceutical industry and relative implact of its major players. *J Cleaner Production*. 2019;214:185-194. doi: 10.1016/j.jclearpro.2019.11.204.
10. Esaki RK, Macario A. *Wastage of Supplies and Drugs in the Operating Room*. 2015:8-13.
11. MacNeill AJ, et al. The Impact of Surgery on Global Climate: A Carbon Footprinting Study of Operating Theatres in Three Health Systems. *Lancet Planet Health*.2017;1:e360–367. doi:10.1016/S2542-5196(17)30162-6.
12. Shoham MA, Baker NM, Peterson ME, et al. The environmental impact of surgery: a systematic review. 2022;172:897-905. doi:10.1016/j.surg.2022.04.010.
13. Ryan SM, Nielsen CJ. Global warming potential of inhaled anesthetics: application to clinical use. *Anesth Analg*. 2010;111:92-98. doi:10.1213/ANE.0B013E3181E058D7.
14. Kalogera E, Dowdy SC. Enhanced recovery pathway in gynecologic surgery: improving outcomes through evidence-based medicine. *Obstet Gynecol Clin North Am*. 2016;43:551-573. doi: 10.1016/j.ogc.2016.04.006.
15. Casey JA, Karasek D, Ogburn EL, et al. Retirements of coal and oil power plants in California: association with reduced preterm birth among populations nearby. *Am J Epidemiol*. 2018;187:1586-1594. doi: 10.1093/aje/kwy110.
16. Zhang L, Liu W, Hou K, et al. Air pollution-induced missed abortion risk for pregnancies. *Nat Sustain*. 2019:1011–1017.
17. Benmarhnia T, Huang J, Basu R, et al. Decomposition analysis of Black-White disparities in birth outcomes: the relative contribution of air pollution and social factors in California. *Environ Health Perspect*. 2017;125:107003. doi: 10.1289/EHP490.
18. Leslie HA, van Velzen MJM, Brandsma SH, et al. Discovery and quantification of plastic particle pollution in human blood. *Environ Int*. 2022;163:107199. doi: 10.1016/j.envint.2022.107199.
19. Ragusa A, Svelato A, Santacroce C, et al. Plasticenta: first evidence of microplastics in human placenta. *Environ Int*. 2021;146:106274. doi: 10.1016/j.envint.2020.106274.
20. Zota AR, Geller RJ, Calafat AM, et al. Phthalates exposure and uterine fibroid burden among women undergoing surgical treatment for fibroids: a preliminary study. *Fertil Steril*. 2019;111:112-121. doi: 10.1016/j.fertnstert.2018.09.009.
21. Thiel CL, Eckelman M, Guido R, et al. Environmental impacts of surgical procedures: life cycle assessment of hysterectomy in the United States. *Environ Sci Technol*. 2015;49:1779-1786. doi: 10.1021/es504719g.
22. Malhotra GK, Tran T, Stewart C, et al. Pandemic operating room supply shortage and surgical site infection: considerations as we emerge from the Coronavirus Disease 2019 Pandemic. *J Am Coll Surg*. 2022;234:571-578. doi: 10.1097/XCS.0000000000000087.
23. Siu J, Hill AG, MacCormick AD. Systematic review of reusable versus disposable laparoscopic instruments: costs and safety. *ANZ J Surg*. 2017;87:28-33. doi:10.1111/ANS.13856.
24. Berríos-Torres SI, Umscheid CA, Bratzler DW, et al; Healthcare Infection Control Practices Advisory Committee. Centers for Disease Control and Prevention Guideline for the Prevention of Surgical Site Infection, 2017 [published correction appears in: *JAMA Surg*. 2017;152:803]. *JAMA Surg*. 2017;152:784-791. doi: 10.1001/jamasurg.2017.0904.
25. Rizan, Chantelle, Lillywhite, et al. Minimising carbon and financial costs of steam sterilisation and packaging of reusable surgical instruments. *Br J Surg*. 2022;109:200-210. doi:10.1093/BJS/ZNAB406.
26. Sustainability Benchmarking Report, 2010. Practice Greenhealth. https://www.practicegreenhealth.org. Accessed December 11, 2022.