A Roadmap for Environmental Sustainability of Plastic Use in Anesthesia and the Perioperative Arena

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Anesthesia and perioperative care, particularly in high-income nations, have become increasingly reliant on single-use plastic disposables from face masks through breathing circuits to IV giving sets.[1–3] In the United States, it is estimated that operating rooms contribute approximately 30% of the 5 million tons of waste generated by hospitals annually.[4,5] A quarter of the solid waste associated with surgery is likely to be of anesthesia origin, with plastics forming almost half of the total anesthetic waste volume.[3]

Plastic products have been massively used since the 1950s and are now recognized widely to be a major environmental burden.[6] Of the cumulative 7.8 billion tonnes of plastic waste generated between 1950 and 2015, only 9% have been recycled and the rest incinerated (12%) or discarded in landfills or the natural environmental (79%).[6] As the COVID-19 pandemic rages on, the unprecedented surge of production, consumption, and disposal of single-use plastics and high demand for plastic personal protective equipment (perceived as more "hygienic" than reusable alternatives) are likely to worsen the plastic pollution problem.[7,8] It is now time to seriously consider perioperative greening strategies that can help reduce the operating room plastic footprint and support a circular economy in which materials recirculate through closed loops of reuse, recycle, reprocess, and repurposing that maximize the product life cycle.[1]

In this review, we survey the current landscape of plastic use and disposal in the perioperative setting. For the anesthesia clinical champions and "green team" leaders, we outline a series of evidence-based "reduce, reuse, and recycle" as well as "rethink" and "research" recommendations toward building environmental sustainability for plastics in the operating room.

The Operating Room Plastic Waste Problem

Solid waste from the operating room can be categorized into two broad streams: (1) general solid waste (~85%, according to World Health Organization benchmarks) and (2) biohazardous or regulated medical waste (~15%).[9] Solid waste is comparable with domestic household waste and includes papers, plastic disposables, and packaging materials. Regulated medical waste encompasses sharps, pharmaceuticals, and other waste that may be contaminated by human blood or other potentially infectious materials and thus requires expensive and energy-intensive treatment (*e.g.*, autoclave, incineration; estimated to cost 7 to 10 times that of normal solid waste) before it can be transferred to final disposal, such as a landfill.[10]

Waste audits from the Western Hospital in Australia found that plastics constitute 48% of the general anesthesia waste stream (by weight) and represent a large portion (62%) of recyclable waste.[3,10] The common plastics generated in the operating room include the following: polyethylene (28 to 39% of all plastics; *e.g.*, flexible plastic packaging); polyvinyl-chloride (23 to 41%; *e.g.*, IV giving sets, oxygen tubing); polypropylene (9 to 21%; *e.g.*, paper looking instrument wraps); and co-polymers (10 to 13%; *e.g.*, syringes; table 1).[3,10] Because almost all anesthesia supplies (*e.g.*, syringes, circuits, and many small objects) are sealed in disposable plastic wraps, packaging from a single major surgical case can easily fill up several large waste bags.

Plastics have taken a stronghold in the medical device industry because of their exceptional barrier properties, low cost, flexibility, and durability.[11,12] However, the same chemical building blocks and additives (*e.g.*, endocrine-disrupting bisphenol-A [BPA] and phthalates) that make plastics so versatile also render them resistant to many natural processes of degradation.[13] These plastics can persist in the environment as microplastics (smaller plastic fragments less than 5 mm) for hundreds of years, with the potential to contaminate and bioaccumulate up the food chains through agricultural soils and the water supply.[13] Growing literature associates additives in plastics and their metabolites with an array of negative health outcomes, including cardiovascular disease, cancer, and endocrine disruption.[11]

Reduce/Avoid

Implementation of a circular economy for plastics relies on reduce, reuse, and recycle, as well as rethink and research.[1]

This article is featured in "This Month in Anesthesiology," page A1.

Submitted for publication February 5, 2021. Accepted for publication May 4, 2021. Published online first on June 11, 2021. From the Faculty of Medicine, University of Alberta, Edmonton, Alberta, Canada (M.Z.X.X.); Department of Anesthesiology and Pain Medicine, University of Toronto, St. Joseph's Health Centre, Toronto, Ontario, Canada (S.A.A.A.); Department of Anesthesiology and Pain Medicine, University of Toronto, Toronto General Hospital, Toronto, Ontario, Canada (L.B.); Environmental Compliance, Energy & Sustainability, University Health Network, Toronto, Ontario, Canada (E.R.); and Department of Anesthesiology and Pain Medicine, University of Toronto, Toronto Western Hospital, Toronto, Ontario, Canada (V.W.S.C.).

 Anesthesiology 2021; 135:729–37. DOI: 10.1097/ALN.0000000000003845

<zdoi;. DOI: 10.1097/ALN.0000000000003845>

Table 1. Common Single-Use Plastics Used in Anesthesia and Best Practices for Their Disposal

Plastic Type	Resin Identification Code	Examples in anesthesia	Recyclable*	Waste Management Best Practices	Volume
Polyethylene terephthalate	1 PETE	• Half-paper/half-plastic instrument wraps (*e.g.*, wraps for warming blankets) • Saline and water ampoules	Yes‡	• The requirement for sterility means nearly all anesthesia supplies (*e.g.*, syringes, circuits, and small objects like connectors) are packaged in disposable polypropylene or polyethylene instrument wraps. • If the hospital's recycling vendor does not accept soft plastic forms, flexible plastic packaging can be managed through disposal in landfills, when available.	28–39%
Low-density polyethylene	4 LDPE	• Packaging for syringes, oxygen masks, IV giving sets • IV fluid bottles, tubing, single-dose ampoules	Yes‡		Unknown‖
Polypropylene	5 PP	• Paper-looking sterile wrapping material for instruments • Forced air-warming blankets	Yes‡		9–21%
High-density polyethylene	2 HDPE	• Irrigation solution bottles	Yes	• Most recycling programs accept high-density polyethylene in the form of rigid plastics	Unknown‖
Polyvinyl chloride	3 V	• Airway equipment: oxygen masks, oxygen tubing, nasopharyngeal airway • IV/irrigation fluid bags and giving sets • Suction tubing	Yes§	• Polyvinyl chloride can be difficult to recycle unless the hospital has a medical polyvinyl chloride recycling partnership. • The current practice is to place polyvinyl chloride supplies into general waste if they are not saturated† with blood or body fluids. • We strongly encourage diverting polyvinyl from landfills (see "Recycling" section for our PVC 123 recycling pilot).	23–41%
Polystyrene	6 PS	• Spinal, epidural, and central line trays	Yes§	• Polystyrene can be solid or foamed. Although the most common form of polystyrene is Styrofoam, hard plastic polystyrene trays are widely used across operating rooms. • Many recycling programs accept solid polystyrene plastics.	6%
Polypropylene/ polyethylene copolymers	7 OTHER	• Syringes • IV cannula covers • Yankauer suckers	No	• Syringe and Yankauer suckers are difficult to recycle. • The current norm is to dispose of copolymer instruments used in the preparation of noncytotoxic medications as general waste	10–13%

Modified from Wyssusek *et al.*[19] Data are from the 2009 and 2015 McGain *et al.*[3,10] prospective operating room waste audits.

*Not all items are recyclable in all jurisdictions. †Saturated entails that the soiled items would express human blood or blood products if compressed and must be segregated and managed accordingly (e.g. autoclave, incineration). ‡Only rigid forms of type 1, 4, and 5 plastic are recyclable. Soft plastic forms are not accepted by most recycling partners because the international market for soft plastics is weak. §Polystyrene, polyvinyl chloride collection available in some areas. ‖The low-density and high-density polyethylene plastic types were not predefined categories and were not counted in the 2009 and 2015 McGain *et al.*[3,10] prospective operating room waste audits.

IV, intravenous.

In their landmark global plastic analysis, Geyer *et al.*[6] concluded that "recycling delays, rather than avoids, final disposal." Thus, waste reduction should be prioritized instead of relying on "wish-cycling" (*i.e.*, putting objects in the recycling bin with the hope it will be recycled) to cover up consumption, as "the best waste is that which is not produced".[14]

For example, open, unused syringes are usually discarded after the end of a procedure because of infection concerns, resulting in a pervasive source of material wastage in the operating room. Several studies have shown that around 50% of provider-prepared resuscitation drugs (*e.g.*, epinephrine, ephedrine, and lidocaine) are not used, wasting up to 25% of the total anesthesia drug budget.[15–18] In one study, ephedrine was found to be wasted 60% of the time that it was prepared, costing the institution an extra $55,100 and 5,622 syringes per year.[15] The magnitude of preventable drug waste is a cause of concern and calls for interventional education and waste-reduction strategies. For example, instead of drawing up emergency medications for every case, drug ampoules and syringes can be kept unopened but immediately available for preparation when needed.[16] The exception is for cases in which surgery/anesthetic-related complications are anticipated, in which case prophylactic loading of resuscitation drugs is warranted.[16]

An alternative measure is to switch from single-dose drug ampoules to labeled, prefilled syringes for commonly prepared anesthetic medications.[19] Prefilled syringes, commercially available or hospital pharmacy prepared, are sterile up to the moment of injection and, if unused, may be carried over for another case.[20] This reduces the need for drawing up resuscitation drugs before each case without limiting specific drug selection by anesthesia providers.[19]

Reuse

Comparative life cycle assessment offers a methodology to gauge the relative environmental and financial benefits of reusables *versus* disposables across all stages of the product life cycle (*i.e.*, cradle-to-grave), from material extraction through production, use, and disposal.[21] It is a common misconception that disposable items, with their lower procurement and maintenance costs, are more economical than reusable items.[22] However, several life cycle assessments examining the environmental impacts and total cost of ownership among anesthesia equipment, including laryngeal mask airways,[23] drug trays,[24] breathing circuits,[2] and laryngoscopes,[25] have shown that reusable alternatives are more cost-effective than single-use products in the long run despite costs of labor and sterilization. A good example is laryngoscope handles. A U.S. study has shown that reusable handles (composed of stainless steel) were more economical and environmentally preferable to single-use handles (composed of polyvinyl chloride or stainless steel) if they merely last 4 to 5 uses (~1% of manufacturer-rated lifetime use).[25] When extrapolated over 1 yr at a single institution (60,000 intubations), disposable handles generate approximately 25 times more greenhouse gas emissions than reusable options and increase overall costs by an estimated $495,000 to $604,000 depending on the cleaning scenario.[25]

Modeling the environmental costs between reusable and disposable device options is more complex because of different energy sources (*e.g.*, coal *vs.* renewables) available to different countries. Studies have shown that reusable equipment has the same or slightly higher carbon footprint in Australia where electricity is principally based on coal, which produces higher carbon dioxide emissions.[2] In contrast, when non-coal fuel sources are used (*e.g.*, natural gas, wind power), converting to reusable can result in a 48 to 84% reduction in carbon dioxide emissions.[2,25] Thus, the environmental benefit that reusables have over single-use equipment is heavily dependent on the source of energy available to manufacture and clean the equipment; if "dirty" energy poses a barrier to the eco-efficiency of reusable instruments, focused attention is needed to improve access to cleaner energy sources instead of relying on disposables.

Reuse of anesthesia breathing circuits is another consideration. Whereas most anesthesia departments in North America prefer a new circuit for each patient,[26] the German Anesthesiology Society, for example, supports the reuse of "single-use" circuits for seven days with a high-efficiency mechanical filter at the circuit Y for each patient.[27] From a microbiologic standpoint, studies have found no significant differences in microbial contamination in breathing circuits used for 24 h *versus* extended use (48 h to 7 days) in the presence of single-use, high-efficiency air filters.[28,29] However, circuits should still be changed between patients for highly infectious cases or if visibly contaminated.

Recycle

Recycling should be considered when "reduce" and "reuse" have been maximized.[30] Manufacturing goods from recycled plastics uses around one-quarter to one-third of the energy compared with the production of new plastics using virgin materials.[31] Recycling can also decrease the amount of waste sorted to landfills or sent for costly and unneeded biohazardous treatment. It is estimated that about 40% of total anesthesia waste is potentially recyclable,[3] with the majority of this waste (50 to 80%) accumulated during the case set-up phase before the patient enters the operating room (and thus is noncontaminated and potentially recyclable).[5,32] Despite this, one study reported that up to 92% of perioperative solid waste was improperly segregated and sent for unneeded biohazardous processing.[33] A survey of the American Society of Anesthesiologists (ASA; Schaumburg, Illinois) further found that the majority of respondents (56%) incorrectly assumed items coming into contact with the patient should be disposed of as biohazardous waste.[34] Superficially, this highlights an inadequate awareness of waste management procedures by medical personnel and points to a need for improved provider education. Beneath the surface, however, there are more deeply rooted individual- and system-level barriers to environmental sustainability efforts, from a lack of strong organizational support, staff attitudes (*e.g.*, inconvenience of recycling, belief that much of what is put into the recycling bins does not end up being recycled, fear of negative repercussions for incorrectly disposing of infectious waste as non-hazardous), perceived infectious risks of separating recyclables from clinical waste, time constraints (*e.g.*, recycling perceived as interruptions/distractions from patient care), and structural barriers that limit recycling (*e.g.*, lack of recycling receptacles in the theatre, local mandates to incinerate used opioid vials that are void of content to reduce the potential for diversion).[35–38] Furthermore, most recycling vendors lack the infrastructure and local market to process all recyclables domestically and instead rely heavily on shipping overseas to China and other international "end markets."[39] Before 2018, China was the world's largest plastic importer and handled nearly half of the world's recyclable waste.[39] But when China enacted its "National Sword" policy in 2018 and banned the import of nonindustrial plastic wastes, previous large exporters such as the United States, Canada, and the United Kingdom have struggled to handle the increase in domestic recycling demands.[39–41] In the current unstable domestic market, the list of recyclable materials fluctuates and large proportions of previously recyclable plastics are now landfilled or incinerated.[39]

A recent national survey among Canadian anesthesiologists found a lack of support from hospital leaders (63.5%), inadequate levels of knowledge (62.8%), apathetic staff attitudes (52.2%), and lack of recycling facilities (51.5%) to be the foremost barriers for recycling.[36] Responses from anesthesiologists in Australia, New Zealand, and England further emphasize inadequate recycling facilities (49%), negative staff attitudes (17%), and inadequate information on how to recycle (16%). Although most respondents (93%) were willing to recycle anesthesia waste, only 11% reported that waste was recycled in their operating rooms.[42]

Despite these challenges, anesthesiologists have emerged as powerful champions of the growing sustainability movement by leading their hospital green teams and leveraging their clinical expertise to initiate recycling and sustainable waste management programs. In 2009, the Vinyl Council of Australia (St Kilda, Australia) initiated a polyvinyl chloride recycling initiative; after great success, the program has since been adopted by more than 140 hospitals across Australia and New Zealand.[43] Following in their footsteps, St. Joseph's Health Center in Toronto started its own pilot in 2016, and in 2020, along with Humber River Hospital (North York, Ontario), became the first centers in Canada to launch PVC 123, a medical polyvinyl chloride recycling initiative in partnership with the Vinyl Institute of Canada (Oakville, Ontario) and Environment and Climate Change Canada (North York, Ontario).[44,45] Operating rooms were outfitted with collection receptacles to seamlessly collect unsoiled polyvinyl chloride medical devices (*i.e.*, oxygen masks/tubing and fluid bags) so that they can be converted into new products, such as hoses, tubing, and automotive supplies.[45] Over the course of this 6-month pilot, it is estimated that at least 80,000 pounds of recyclable polyvinyl chloride will have been diverted from landfills.[44,45] The program has now been initiated across five other Toronto hospitals, with plans to expand to British Columbia.[44,45]

For hospitals looking to establish plastics recycling in patient care settings, the Sustainability Roadmap (developed by the American Hospital Association [Chicago, Illinois] and affiliates),[46] the HospiCycle toolkit (created by the Healthcare Plastics Recycling Council [St. Paul, Minnesota]),[47] and the ASA sustainability manual[48] are valuable, vendor-neutral resources that can help institutions set up recycling programs. The Sustainability Roadmap recommends assembling a sustainability committee that brings together decision-makers and centralizes responsibilities.[49] This group should comprise the following; (1) senior leadership (authority to approve capital investment and equipment purchases); (2) representatives from support services such as Facilities, Environmental Services, and Procurement to manage the operational infrastructure for sustainability practices; (3) a sustainability officer whose primary responsibilities are to lead environmental initiatives and collect statistics; and (4) multidisciplinary clinical champions (e.g., front-line healthcare providers, surgeons, anesthesiologists, nurses) who volunteer their time to liaise communication efforts between environmental services and departments and coordinate staff education and action plans. We would take this further to call regular meetings with representatives from the hospital's solid waste, recycling, and biomedical waste haulers given their key stakeholder status. As well, the dyad leadership model has proven to be effective. Having a clinical and nonclinical sustainability lead would be very beneficial in this space.[50,51] Like any organization-wide effort, buy-in and support from senior leadership are critical to foster the culture change needed to launch and maintain the program's long-term success. When executives perceive that the organization is committed to sustainability, they internalize these values and respond with proenvironmental behaviors that trickle down to employees.[52]

Before starting the actual recycling operations, it will be important to first conduct a prospective waste audit (internally or with third-party auditors) to benchmark the operating room waste stream and determine what portions could be targeted by a recycling program.[53] Work closely with your recycling partners to evaluate what types/forms of plastic materials are acceptable for recycling and whether they must be collected separately or can be commingled.[53] Some recycling vendors accept rigid plastics with no accompanying plastic resin code, whereas others do not process unmarked plastics. To improve the situation, we have worked with manufacturers and suppliers to encourage appropriate coding of unlabeled items so that they can be accepted by our local recycling provider.

With public and regulatory attention focused on hospital waste disposal, there are institutional fears of reprimand for improper medical waste management. Even in the prepandemic period, Canadian anesthesiologists raised concerns about disease transmission through the recycling of biologically contaminated materials.[36] One method to minimize the risk of contamination and increase compliance is single-stream or commingled recycling, where all recyclables are placed into the same receptacle. Several single-stream operating room recycling pilots have achieved recycling rates of more than 40 to 50% without infectious contamination or cost burden.[10,54,55] Some recycling programs have even returned a financial benefit (~40,000 USD per year) by selling their recyclables to recycling companies instead of paying waste management companies to landfill recyclable waste.[54]

Providing adequate waste segregation training, with refreshers multiple times during the year, is vital to the recycling program.[36,55,56] Teaching, based on local regulations, should clarify the appropriate items for each regulated and nonregulated stream, and where interpretation is possible, safe and sustainable practices should be at the forefront. Visual aids, such as waste wizards/charts illustrating what items go into each waste receptacle, should be displayed in staff lounges and on the operating room walls. It is also important to measure program performance through periodic audits and provide measurable results, such as disseminating waste reduction outcomes regularly (*e.g.*, in hospital newsletters) to energize and engage staff members.[14,56]

Reprocessing

Many noncritical medical devices that come into contact with unbroken skin (e.g. fingertip oxygen sensors) are labeled as single-use by manufacturers and not by regulatory bodies. Medical device reprocessing involves the cleaning and packaging of "single-use" equipment (e.g., laparoscopic instruments, ventilator circuits) for reuse and is a safe and effective way to divert devices from landfills and return them to service.[57] Both the U.S. Food and Drug Administration (Silver Spring, Maryland) and Health Canada (Ottawa, Ontario) have approved certain third-party reprocessors under stringent safety and quality guidelines, where each reprocessed device must be "substantially equivalent" to the predicate device.[58,59] Thus, reprocessing medical devices can significantly reduce the biomedical waste stream volume, translating to a reduction of waste management costs.[57] Hospitals also have the option of buying reprocessed devices at discounts, saving up to 40 to 60% on the cost of buying new.[57]

Table 2. A Proposed System for Segregating General and Clinical Waste at the Point of Generation

Waste Category	Takeaways and Recommendations	Destination
Recyclable solid waste	• Market incentives and local regulations are the major factors that create plastic recycling opportunities (*i.e.*, what is recyclable in one hospital could be landfill waste in another). The presence of a recycling logo on a plastic item does not guarantee the product is recyclable locally. • Disposing nonrecyclable items into the recycling container leads to recycling contamination and wasted recycling effort (all materials end up in landfills) • Hospitals looking to implement a plastic recycling program should first conduct an operating room walk-through with the hospital recycling provider and environmental services staff to determine waste recyclability and create a Waste Wizard sorting tool that guides proper recycling and disposal practice in the operating room. • Single-stream recycling (if accepted by the recycler) allows the hospital to comingle all recyclable material into one collection bin, which simplifies the recycling process. • Consider placing recycling bins near the anesthesia workstation to encourage recycling.	United States/Canada/Europe/Australia: To a material recovery facility for sorting.
Nonrecyclable solid waste	• The international market for soft plastics is weak, so soft plastics recycling is not available at most hospitals. • If soft plastics collection is not available on-site, these nonhazardous materials should be discarded into regular waste containers. • Uncontaminated emptied syringes (without needles) can be placed in regular waste containers.	United States/Canada: To landfill (no treatment required) Europe/Australia: In some jurisdictions, all medical wastes (including syringes and plastic disposables) are incinerated.
Noncytotoxic biomedical waste	• These are contaminated items that would express human blood or blood products when compressed (*e.g.*, blood-soaked sponges). • General solid waste is often misclassified as hazardous waste. Some hospitals have reported significant reductions in biohazardous waste volumes (approximately 75%, with estimated saving USD 50,000 USD a year) when they increased the size of general waste bins and placed much smaller biohazard bins in the theater.[56]	United States/Canada/Europe/Australia: Autoclave or incineration prior to landfill
Noncytotoxic sharps waste	• The sharps container should only hold items capable of puncturing the skin (*i.e.*, lancets, scalpel blades, needles without attached syringes, exposed IV spikes) and not, for example, the empty syringe itself to limit overfilling with waste that can be recycled or landfilled in some jurisdictions. • For safe sharps disposal, consider reusable sharps containers with a needle adaptor that can lock the needle and automatically twists it off the syringe, allowing the disposal of only the needle instead of the entire syringe and needle unit. • Anesthesiologists routinely remove medication draw needles to inject at a needleless IV port. In this instance, at the end of use, the needle alone should be discarded in the sharps container, whereas the emptied syringe may be discarded as general waste.	United States/Canada/Europe/Australia: Single-use sharps containers will be autoclaved or incinerated whole, but reusable sharps containers are decanted and only the contents are treated (either autoclaved or incinerated).
Pharmaceutical waste	• Pharmaceutical waste is often incinerated which is costly (up to 7–10× compared with landfill) and produces many environmental toxins (hydrochloric acid, dioxins, and furans).[11] • Residual noncytotoxic liquid medications (*e.g.*, partially filled syringe doses or half-empty IV bags) should be expelled into the pharmaceutical waste disposal bin (if available). Once emptied, the plastic container (*e.g.*, empty syringe, IV bag with trace nonhazardous content) can be recycled or landfilled, depending on disposal options. • Reusable pharmaceutical waste containers/drums are more economical and sustainable alternatives to single-use containers.	United States/Canada/Europe/Australia: Incineration

IV, intravenous.

Rethink and Research

Moving forward, the transition to environmentally sustainable healthcare will depend on two further "Rs": rethink and research. Hutchins and White raised the ergonomic redesign of the operating room and waste receptacles so it would be more feasible to recycle than to dispose.[60] We extend this to a more standardized system for segregating general and biohazardous waste at the point of generation (table 2). It will be important for the institution to implement a consistent color scheme to help reduce ambiguity and prevent the mixing of waste streams. Other avenues to reduce environmental impact include the donation of open-but-unused operating room supplies to developing nations (see the REMEDY program at Yale, Not Just Tourists),[61,62] reformulating operating room kits (*e.g.*, removing items that are routinely unused during procedures),[54] and preferentially purchasing supplies and equipment from companies that align with the hospital's sustainability goals.[60] When optimizing their supply chain decisions, hospitals should also contemplate putting pressure on manufacturers for more environmentally conserving packaging and extended producer responsibility, where manufacturers of the product are responsible for the take-back, remanufacturing, recycling, and end-of-life management of the product.[63]

The accumulation of plastic wastes during the pandemic also calls for research into new sterilization techniques and new methods for reprocessing personal protective equipment, such as pyrolyzing and gasification techniques that convert plastics into liquid or gaseous fuel, respectively.[64]

Conclusions

Solid healthcare waste, greatly influenced by single-use plastics, is an ever-increasing issue worldwide, and all physicians have an ethical obligation to provide care along the continuum of patient and planet health.[65] Anesthesia and perioperative care contribute significantly to the plastic waste burden, and its proportional impact will likely be aggravated by the excessive consumption of single-use plastics because of concerns about infectious diseases, current and future (*e.g.*, COVID-19), and the rising demand for surgical services in an aging population.[7,8,66] The call for a restorative circular economy for plastics will require the collaboration between diverse stakeholders, from government, regulators, to hospital executives, senior leadership, Environmental Services, and frontline staff. Anesthesiologists are well positioned to serve as leaders of a multidisciplinary operating room green team and lead the charge to foster the culture change needed to implement and maintain long-term sustainability efforts.

Acknowledgments

The authors thank Lisa Vanlint, B.A. Hons. (Energy Steward at the University Health Network, Toronto, Ontario), for useful discussions.

Research Support

Support was provided solely from institutional and/or departmental sources.

Competing Interests

The authors declare no competing interests.

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ANESTHESIOLOGY REFLECTIONS FROM THE WOOD LIBRARY-MUSEUM

Robert-Houdin's "Ethereal Suspension" and the Birth of Theatrical Magic

A sleight of hand seemed to have piqued Jean-Eugène Robert-Houdin's interest in magic. The son of a watchmaker, he had saved up to buy a set of books on clockmaking, only to discover that a set on magic had been packaged instead. Nevertheless, he was captivated. Eventually, Robert-Houdin began to perform as an illusionist at private parties in elegant Parisian parlors. He dreamed of moving magic shows from local fairs to venues as refined as the homes that employed him. In 1845, he built a small but sumptuous theater on the grounds of the old Palais-Royal. With persistence, he won the respect of magic devotees and society's elite, and in 1852, the Théâtre Robert-Houdin moved to a larger permanent space (advertised *left*). One of his best-known acts debuted in 1847 and exploited the contemporary fascination with ether (*lower right*). His youngest son, Eugène, stood onstage on a center stool, with his arms resting on two canes that leaned on outer stools. After sniffing (an empty bottle of) ether, Eugène went limp. His father removed the middle stool, and then the left cane. Next, his little finger alone appeared to lift the boy's entire body horizontally. When the father stepped away, his son levitated in midair, his right elbow balancing effortlessly on the remaining cane (*upper right*). A visual spectacle, Robert-Houdin's "Ethereal Suspension" appeared to elevate not only the human form, but also the status of magic in the public eye. (Copyright © the American Society of Anesthesiologists' Wood Library-Museum of Anesthesiology.)

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