



Sustainability in Ophthalmology

Going green for the future of eye care.

By Reena Mukamal, Contributing Writer

THE HEALTH OF THE ENVIRONMENT IS INSEPARABLE FROM ocular and public health.¹ Air pollution, for example, has been linked to an increased risk for a number of eye conditions.^{2,3} Although surveys show that ophthalmologists around the world are nearly unanimous in the opinion that waste in ophthalmology should be reduced, more than a third are unaware of the economic and environmental burden that waste creates.⁴ Gaining a better grasp of how much and what types of waste are produced in ophthalmology, and being open to changes that will reduce that waste, will make the field more sustainable, say ophthalmologists who are working in their practices and the broader medical community to reduce the carbon footprint of eye care.

An Emergency and an Imperative

Understanding surgical waste. In 2021, the World Health Organization declared climate change the single biggest health threat to humanity, and the International Agency for the Prevention of Blindness has entreated ophthalmologists to show leadership and fast-track efforts to mitigate harmful effects of their practices. Health care accounts for nearly 5% of all greenhouse gas emissions globally (10% in the United States). Those emissions are generated by power consumption in operating rooms, the production of medication and device packaging (and trash and recycling processes after use), and transportation (patients, staff, and shipping of medical supplies), among other sources.⁵

A measure of greenhouse gas generation, carbon footprint is defined as the emissions associated with the full life cycle of a product or event and is measured in carbon dioxide equivalents (CO₂-eq), per a new chapter on sustainability in the Academy's 2024 edition of the *Basic Principles of Ophthalmic Surgery (BPOS)* book. The new *BPOS* chapter notes that the carbon footprint of cataract surgery can range from 6 kg CO₂-eq in a center in India to 181.9 kg CO₂-eq in the United Kingdom.

According to one study, a single cataract procedure in the United Kingdom generates the same level of carbon emissions as driving a typical nonelectric car 310 miles.⁶ In the United States—where 3.7 million cataract procedures are performed each year—the waste is even greater, said Aakriti Garg Shukla, MD, at Columbia University Irving Medical Center. “Current practices in the UK and other Western nations lead to 20 times more waste produced with every cataract surgery compared to some institutions in India,” said Dr. Garg Shukla.

Globally, 20 million cataract surgeries are conducted annually. Ophthalmology's environmental impact is only growing; in the decades ahead, an aging population will increase the demand for cataract surgery—and in turn, increase waste from the procedure, said John C. Buchan, FRCOphth, MD, at the International Centre for Eye Health at the London School of Hygiene and Tropical Medicine.

Recognizing an opportunity. Because cataract surgery is the highest volume surgical procedure of all medical specialties globally, ophthalmology has both an opportunity and an obligation to make its services more sustainable, said David F. Chang, MD, at the University of California, San Francisco.

However, efforts to address needless waste in ophthalmology—both in and out of the operating room—have been fragmented and not a major focus of the profession, until now.

Uniting efforts. The Academy formally joined EyeSustain (www.eyesustain.org) as a sponsoring society in the fall of 2022—joining the American Society of Cataract and Refractive Surgery (ASCRS) and the European Society of Cataract and Refractive Surgeons—and is a member of the advisory board. A digital hub, EyeSustain aims to both educate the ophthalmology community about adverse environmental effects of eye health care delivery and to help network individuals and groups in efforts that mitigate excessive waste, said Dr. Chang. The EyeSustain Resource Library contains links to more than 60 articles and resources on sustainability in ophthalmology (including articles and editorials from *Ophthalmology* and *EyeNet*). EyeSustain is continually updated with resources that can help ophthalmologists to advocate for and advance more sustainable practices in the profession. According to Dr. Chang, 39 global organizations have also joined as EyeSustain member societies.

Academy task force. While the EyeSustain initiative primarily focuses on anterior segment conditions, in-house efforts at the Academy also include the Sustainability Task Force initiative. Jeff Pettey, MD, MBA, at the University of Utah, in Salt Lake City, who heads up the task force, said the group's mission is to improve eye health by promoting and facilitating sustainable practices across the full spectrum of ophthalmology's footprint. "The Academy has a long track record of promoting sustainable ophthalmology, from advocacy to the annual meeting. We aim to raise awareness of green practices, promote systemic



REUSING SUPPLIES. Surgical instruments are prepared to be sterilized using short-cycle autoclave at Aravind Eye Hospital, in Pondicherry, India.

change through advocacy, and foster engagement through crowdsourcing ideas and innovations from our membership," Dr. Pettey said.

In February of this year, the Board of Trustees approved the Academy becoming a sponsoring organization of My Green Doctor (www.mygreendoctor.org), which provides practice management resources about environmental sustainability for clinics, offices, and outpatient surgical centers. It also offers practical guidance for office staff and ideas to share with patients.

Greener Operating Rooms

"Energy is expended and emissions are produced in every step of the ophthalmic surgical process," said Dr. Garg Shukla. While some of this consumption is unavoidable, she said there are substantial opportunities to minimize waste.

More than nine of 10 cataract surgeons in both the United States and in Europe agree that operating room waste is excessive, according to research by Dr. Chang and colleagues, who concluded that surgical waste can be reduced with focused efforts.⁷ Change requires revisiting, updating, and challenging outdated processes and regulations, said Dr. Chang. For example, infection control policies for general surgery are universally applied to all procedures by default, but they should be reevaluated to determine how to maintain high infection control standards while minimizing waste, he said.

Lighter surgical pathways. Historically, cataract surgery has required patients to make six or more visits to and from an ophthalmologist's clinical practice and surgery center, which can add up to significant CO₂ emissions due to the many miles traveled, said Dr. Buchan. The necessity of so many visits is under global reexamination. He said, "NHS England provides over half a million

cataract operations per year and has adopted a policy of ‘patient initiated follow-up (PIFU)’ whereby patients are seen post-op only if they have perceived problems.” It is a policy that has been gaining traction since the COVID pandemic began, said Dr. Buchan, adding, “The Royal College of Ophthalmologists—the U.K. version of the Academy—has been promoting this increasingly since 2021, but it is still in a process of change-over.” Since initiating this change, he said that the United Kingdom has saved around 150,000 outpatient visits each year.

In India, more than 16,000 patients used local vision centers and telemedicine for postoperative visits in 2022 in lieu of traveling to hospital for in-person appointments, said Rengaraj Venkatesh, MBBS, at Aravind Eye Hospital, in Pondicherry, India. “That is an estimated reduction of 1.3 million miles traveled or 270 tons of CO₂ emissions,” he said.

Surgery, too, is seeing savings after making changes. Due to its improved safety profile, immediate sequential bilateral cataract surgery (ISBCS) is growing worldwide, said Dr. Buchan. Hospitals achieve higher productivity and cost savings of more than 30% when performing ISBCS.⁸ “The environmental benefits include reduced travel from duplicated pre- and postoperative visits,” Dr. Buchan said. ISBCS is also expanding in Canada and Scandinavia. But in the United States, current CMS reimbursement policy remains a significant barrier to widespread adoption of ISBCS, Dr. Buchan noted.

Multidose eye drop use. Waste is also happening in the area of medication use. For many ophthalmic procedures, a brand-new vial of eye

drops is thrown out after just one administration, even when the patient requires a prescription for the very same drug after discharge. Approximately \$560 million in cataract surgery medications is needlessly discarded each year.⁹ “Not only are topical medications expensive but also they have a surprisingly large carbon footprint and are subject to supply chain and manufacturing shortages,” said Dr. Chang. One study estimated that this waste generates emissions that are equivalent to approximately 22,624 gasoline-powered cars or the electricity use of 20,430 homes⁷ for one year.¹⁰

A 2022 multisociety position paper drafted by the EyeSustain advisory board recommended that multidose bottles of topical medication be used beyond the 28-day limits imposed on injectable drugs, Dr. Chang said. Using multidose preoperative and preinjection eye drops has been estimated to save approximately \$240,000 at one institution over five years, he noted.¹¹

Michael X. Repka, MD, MBA, Academy Medical Director for Governmental Affairs, said getting CMS to update its instructions to facility auditors—clarifying that eye drops are not audited like injectable medications—required an advocacy effort led by the Academy’s D.C. team in collaboration with ASCRS, the American Glaucoma Society, and the Outpatient Ophthalmic Surgery Society. It is an example of how working collaboratively across organizations led to an important regulatory clarification/change, he said, noting that the EyeSustain position paper also has the support of all U.S. state ophthalmology societies.

In the United States, reusing eye drops in cataract surgery is often prohibited by regional pharmaceutical dispensing regulations, said David

How Climate Change Impacts Eye Health

The World Health Organization, American Medical Association, and U.S. Department of Health and Human Services have all declared climate change a public health emergency. A rise in air pollution and pollen is leading to an increased incidence of asthma, allergies, respiratory, and cardiovascular diseases. “Environment and climate change play a great and multifaceted role in eye health, too” said Dr. Venkatesh.

Current studies have estab-

lished a correlational relationship between many ocular diseases—including ocular trauma, trachoma, cataracts, and retinal pathology—and the surrounding environment. These and other diseases are affected by exposure to heat, ultraviolet radiation, ozone, and numerous environmental pollutants.¹ “Keratitis, ocular surface disorders, glaucoma, macular degeneration, uveitis, and allergic conjunctivitis are conditions we’ve seen increasing, especially in highly pollut-

ed areas where studies have been done,” said Dr. Palmer.

Increased frequency of extreme weather events, affecting both local operations and the supply chain, is also likely to disrupt eye health delivery, according to EyeSustain. More research is needed, but without efforts to address climate change, the severity of its impact on eyes is only expected to increase, said Dr. Palmer.

1 Sherry B et al. *J Ophthalmology*. 2023;130(7):702-714.

J. Palmer, MD, at Northwestern University's Feinberg School of Medicine in Chicago. But those regulations have been challenged with the support of the Academy, which created a model Topical Medical Waste Reduction Act template that states can modify and use to push back on bottle disposal regulations. In 2021, legislation in Illinois was signed into law (PA 102-0155) to address this issue, Dr. Palmer said. Based on this model, Delaware, Nebraska, and Tennessee passed similar legislation. "We hope it will continue to gain momentum around the country," he said. This template and the [EyeSustain] position paper are available on the EyeSustain site.

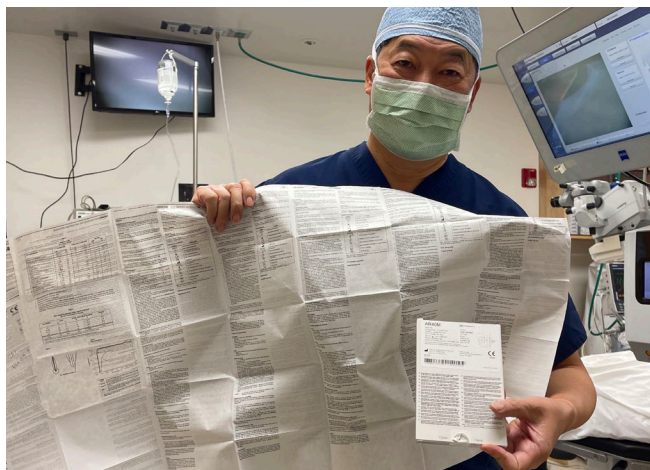
Streamlining surgical supplies.

Disposal of unused surgical supplies is all too common, said Dr. Garg Shukla, who explained that removing consistently unused items from surgical custom packs and preference cards is low hanging fruit when it comes to reducing waste. "Studies have shown that standardizing surgical supplies in vitreoretinal procedures, for example, has improved utilization of resources up to 89%," said Dr. Palmer.¹²

In another example, a children's hospital that excluded items used less than 85% of the time from surgery packs saved more than \$27,000 in costs and eliminated two tons of plastic waste annually.¹³ "Reducing the number of items in your pack to only the essentials helps the environment and the bottom line, and it reduces time in the operating room," said Dr. Garg Shukla.

Reusing instruments. "In the United States, single-use instrumentation leads to immense waste not only of the items themselves but also the packaging they come in," said Dr. Garg Shukla. At this time, manufacturer and FDA restrictions prohibit U.S. surgical facilities and eye surgeons from reusing instruments labeled "single use," including phacoemulsification tips and metal blades. Given the current low rates of post-cataract endophthalmitis, the benefit of these regulations is being revisited, said Dr. Chang.

The Aravind Eye Care System, which includes a network of eye hospitals and clinics in India, routinely reuses surgical instruments in ORs and has a lower rate of postoperative endophthalmitis (0.01%) than the United States (0.04%).¹⁴ U.S. studies are currently underway to assess and demonstrate the safety of ophthalmic supplies, instruments, equipment, and drug reuse in eye surgery, said Dr. Palmer. A single-use label doesn't necessarily mean that reuse is dangerous, which is



A PROFUSION OF PACKAGING. David F. Chang, MD, at UCSF, is working to reduce waste in medical packaging, such as these instructions from an intraocular lens package.

what CMS assumes, said Dr. Chang. There is little incentive for manufacturers to complete the costly and lengthy process required by the FDA to validate a "reusable" labeling claim. It would be more accurate for manufacturers to provide a disclaimer noting that the safety of reprocessing and reusing a product has not been established, Dr. Chang said. This would give surgeons some discretion in reusing products while limiting manufacturer liability, similar to prescribing medicine off label, Dr. Chang said.

Immediate use steam sterilization (IUSS).

IUSS is the replacement term for flash sterilization. In the United Kingdom, Dr. Buchan said he believes cataract surgeons would be willing to use unwrapped surgical kits with steam sterilization "This would allow us to cycle the same sets of surgical instruments repeatedly with proper cleaning but without the need for the excessive packaging and transportation involved in off-site industrial sterilization units."

Aravind Eye Hospital has long practiced steam sterilization of surgical instruments, sleeves, and irrigation/aspiration handpieces in ocular surgery to provide a quicker turnaround time for instruments and to reduce the need for a larger number of surgical packs, said Dr. Venkatesh.

Alcohol-based scrub. Alcohol-based surgical scrub is recommended by leading health organizations for presurgical sterilization. Switching from water-based to alcohol-based hand scrub for surgical prep has been calculated to save more than 61,000 liters of water and more than \$280,000 annually per operating room in one large ophthalmic center.¹⁵

Disposable gowns and drapes. Today, these items account for a significant amount of OR waste even though reusable operating attire for surgeons and a smaller face drape for patients may

be sufficient, said Dr. Palmer. “While surgery on an abdomen may require a head-to-toe drape, an eye surgery does not. Yet we are often required to follow the protocols of all specialty groups, including general surgery, in our facilities,” he said.

At Aravind Eye Hospital, cloth surgical gowns are laundered and routinely undergo full-cycle autoclave cleaning, antiseptic solution is used to rinse gloves between cases, and phaco cassettes and tubing are reused until the end of the day, said Dr. Venkatesh. Each phacoemulsification produces about 5% of the greenhouse gases produced by the same procedure in the United Kingdom.¹⁶

Fine-tuned recycling practices. For waste that is unavoidable, proper sorting and recycling can help minimize the environmental and financial impact. “Subdividing and separating papers, plastics, metals, glass, gowns, drapes, shoe covers, and tubing can make a difference, but not all facilities have adopted these processes,” said Dr. Palmer. Education can change this. After a survey at the Mayo Clinic showed that 57% of clinicians were unclear about which OR items are recyclable, a recycling education program helped Mayo achieve cost savings of 10.3% in sharps waste disposal.¹⁷

Waste segregation—and workforce education around best practices—is a focal point at Aravind Eye Hospital, which sorts recyclables by grade of plastic and paper allowing for maximized returns, said Dr. Venkatesh. Aravind also practices composting on campus.

Overcoming resistance to change. Beyond needed reforms in regulatory policy, evolution

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Take the EyeSustain Surgical Facility Pledge

Ask your surgical facility or ophthalmology department to take the EyeSustain surgical facility pledge featured at www.EyeSustain.org.

- Educate surgical staff about sustainability and the impact of OR waste.
- Regularly reevaluate surgical pack standardization to minimize waste.
- Use multidose bottles of topical medication and betadine on multiple patients when possible.
- Assess the necessity for patient gowns and full body draping.
- Regularly reassess options for reusable versus single-use products and instrumentation.
- Assess feasibility of alcohol-based surgical scrub for presurgical antisepsis.
- Institute or update recycling strategies.

to more sustainable OR practices will require a “hearts and minds shift,” said Dr. Buchan, who noted that surgeons are change resistant when it comes to long-established behaviors. Yet, he said, cataract surgeons are no strangers to change. At one point, many used injectable anesthesia, two separate blades for incisions, and postoperative shields for all eyes; today, these practices have largely been abandoned. “The next set of changes allow surgeons to step into a future that is more sustainable for the growing global population as we disinvest in low-value practices,” Dr. Buchan said.

“Ophthalmology requires you to be receptive to change constantly, with a drive to try out alternatives and breakthroughs that don’t compromise treatment quality and patient outcomes,” said Dr. Venkatesh.

Sustainable Manufacturing

Multiple surveys show that ophthalmologists want manufacturers to offer more reusable options for supplies, drugs, and instruments, said Dr. Chang. Over 50% of greenhouse gas emissions [in ophthalmology] come from supply procurement for materials used for surgery: eye drops, surgical supplies (phacoemulsification tips, tubing, surgical markers, single-use and multiuse surgical tools, packaging), other medical equipment, and laundry, according to the *BPOS* sustainability chapter.

Packaging. Production and manufacturing of medical products results in at least 15% of the industry’s carbon emissions.¹⁸ Because of this, ophthalmologists are urging manufacturers to direct research and development toward more environmentally friendly product design, said Dr. Chang. For example, IOLs often come packaged with large, printed Instructions for Use (IFU) pamphlets, which unnecessarily enlarge the packaging, said Dr. Chang. “These leaflets are in several languages, and nobody reads them,” said Dr. Buchan.

“We are engaging manufacturers to replace the paper with a QR code that can be scanned by a mobile device,” said Dr. Palmer. “Making this change for a 6-millimeter wide IOL, for example, can reduce the weight of the packaging by 50%.”

Unnecessary packaging also impacts the cost of fuel needed for shipping, Dr. Garg Shukla pointed out. Alcon is already incorporating QR coding into lens implant packaging, said Dr. Palmer. One barrier preventing more manufacturers from adopting this change is that more than 60 countries currently do not accept an electronic IFU for medical devices, explained Dr. Chang.

EyeSustain is also engaging with ophthalmic surgical manufacturers to develop preloaded IOL cartridges to be used with reusable metal injectors,

which would eliminate the waste in discarding the entire preloaded plastic injector with its larger box and plastic packaging after every use, said Dr. Chang.

Greener Buildings

Building and energy use represent other important opportunities to reduce the carbon footprint of cataract surgery.¹⁹ At Aravind Eye Hospital, the building design has been optimized for reduced energy and resource demands. “Our infrastructure, including energy efficient HVAC chillers and lighting, a decentralized wastewater treatment system, and a solar grid that produces 60% of the energy required at the site, is also working toward reducing the impact we have on our environment,” said Dr. Venkatesh.

“A green building is something that our practice had been interested in for years,” said Gregory J. Katz, MD, at Huron Ophthalmology in Ypsilanti, Michigan. “In 2009, we built a carbon neutral, 21,200 square foot building for our practice. Geothermal wells were constructed, which supply our heating and cooling—we do not even have a gas line to the building. And solar panels produce about 120% of our electrical needs, so we are able to sell 20% back to the grid.” He said they were expensive to install, and the return on investment was about 7 years, but it now allows them to save “significant funds which we use for other practice improvements.”

Motion sensors were installed for efficient lighting control, their flooring was made from recycled materials, and skylights were installed in their tech station allowing for natural lighting and decreased use of electricity. A bike shed was constructed to encourage employees to bicycle to work. “We originally did these things because we thought that it was the right thing to do for the environment, but it has afforded us significant cost savings over the years, as well as earned us a lot of good will in the community,” said Dr. Katz.

A Path to a More Sustainable Practice

Becoming more sustainable can start with small steps, especially if time is at a premium. Start by visiting [EyeSustain.org](https://www.eyesustain.org). EyeSustain is a global collaboration of more than 40 ophthalmic societies, and it is growing. Dr. Garg Shukla said the website “contains hundreds of evidence-based literature and multimedia files on environmental sustainability in ophthalmology—both in the clinic and the operating room—as well information on pharmaceutical waste and best practices around the world.”

Engage early career ophthalmologists. Ophthalmologists implement practices that they learn during training and see their peers doing, said Dr. Garg Shukla. “Reducing surgical waste was not at

the top of the curricula of most residencies and fellowships [in years past]. But this is starting to change as the Academy and other organizations incorporate sustainability in ophthalmology into annual meetings, publications, and coursebooks,” she said. Trainee surgeons generate approximately a quarter more waste than experienced surgeons,²⁰ so it’s important to engage them in green efforts.

Dr. Pettey said, “The Academy’s *Basic and Clinical Science Course* and companion book *Basic Principles of Ophthalmic Surgery* are the canon for ophthalmic training and practice. Our chapter in *BPOS* focuses on reducing OR waste in surgical practice with recommendations that ensure quality care while minimizing waste and carbon footprint.”

Create a green team. Designate an individual or group to lead sustainable efforts in your surgical center or clinic. “Be the individual or ophthalmologist to speak up, champion waste reduction, and have your facility take the simple EyeSustain Pledge online,” said Dr. Chang.

Dr. Pettey said, “Change starts with physicians as the leaders and architects of their practice culture.” He listed an array of ways to start moving the green needle: “We can utilize reusable surgical instruments, employ energy-efficient equipment and lighting, reduce single-use plastic in clinics, or simply increase recycling throughout our practice.”

He also advised staying up-to-date on resources shared by mygreendoctor.org. Academy members can access materials for free either at mygreendoctor.org or at aao.org/practice-management under the Managing Your Practice tab

Follow-through. Even after a policy is formally changed, barriers to implementation can slow the process, said Dr. Palmer. Take the example of allowing patients to bring home eye drops postoperatively. He said, “At Northwestern, similar to other institutions, it took several years from the passing of the Illinois legislation to see the law put into practice. From hospital and IT teams revamping the medication ordering and labeling process to reprogramming Epic, advocacy is essential pre- and post-policy change.”

“Change can be brought about anywhere, no matter what the barriers are—regulatory, cultural, or economic,” said Dr. Venkatesh. “In a low-resource setting, even the smallest changes toward improving patient flow and experience can reap massive dividends in the form of accessible health care with a marked reduction in carbon emissions.”

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