

ABOUT THE AUTHOR



XAVIER CAMPOS-MÖLLER, MD: Dr. Xavier Campos-Möller is head of the Glaucoma and Advanced Anterior Segment Surgery division of the Department of Ophthalmology at Western Memorial Regional Hospital in Corner Brook, Newfoundland, since 2016. Dr. Campos-Moller is a graduate of the Glaucoma and Advanced Anterior Segment Surgery fellowship with Dr. Ike Ahmed at the University of Toronto. He currently runs a practice in Corner Brook, Newfoundland, focusing mostly on cataract, complex anterior segment, and glaucoma surgery. Dr. Campos-Moller is councilor for the Canadian Glaucoma Society and an active member of the Canadian, American and Mexican Ophthalmological Societies as well as the American Society of Cataract and Refractive Surgeons and the European Society of Cataract and Refractive Surgeons. He has lectured in multiple countries, published over 20 scientific papers in the fields of cataract, anterior segment surgery and glaucoma, and also recently published a best-selling book: *Illustrated Advanced Anterior Segment Surgery*. He is committed to the eradication of blindness and frequently travels overseas for humanitarian surgery missions, having performed thousands of surgeries for those in need. He is currently the president of SeeLevel, an organization committed to providing ophthalmic surgery to those that need it most.

Environmental Impact of Ophthalmology and Related Action Plan: Sustainability Inside and Outside of the Operating Room

Xavier Campos-Möller, MD

Affiliations

Western Memorial Regional Hospital, Corner Brook, NL

Correspondence

Dr. Xavier Campos-Möller
Email: xavo@cbeyecare.com

Climate Change and its Impact on Health

Climate change, global warming, or “global weirding” as some experts call it, is now undeniable. Extreme weather events such as flash floods, fires and hurricanes are increasing in both frequency and intensity. These changes are directly influenced by a changing climate as a by-product of greenhouse gas emissions, principally but not exclusively carbon dioxide (CO₂) and methane (CH₄).¹

In 2021, the Canadian town of Lytton, British Columbia was destroyed by wildfires following three days of record-breaking heat with temperatures rising as high as 49.6°C. This represented an abnormal event that could potentially become frequent if greenhouse emissions are not controlled. Oceans are particularly sensitive to global warming (more than 90% of excess environmental heat is accumulated in the oceans) and they directly contribute to weather patterns due to their close interaction with the atmosphere. The

year 2022 was the hottest year in history for our oceans, even surpassing the previous year's record maximum.² According to a South American report, in 2022 children under one year of age were exposed to 2.35 million more person-days of heatwaves each year vs data from 1996–2005.³

Plastics production has increased twenty-fold over the past 50 years, from 15 million tonnes in 1964 to 311 million tonnes in 2014. This number is expected to rise exponentially. Plastic packaging represents 26% of the total volume of plastics used. Of this plastic packaging produced, 95% or \$80–120 billion USD annually, is not able to be recycled following a short single use.⁴

To further complicate the issue, plastic waste degrades into microplastics (particles under 5 mm in size) and nanoplastics (< 1 µm) when exposed to natural forces such as sunlight and wave action. In vivo studies have demonstrated that nanoplastics can translocate to all organs and there is a growing body of evidence linking micro- and nanoplastic exposure with cellular toxicity, and a likely detrimental effect on health.⁵

Although the effects of microplastics and nanoplastics on human health are not yet fully understood, there is evidence to support the occurrence of increased inflammation, oxidative stress and apoptosis, as well as deleterious effects on metabolic homeostasis.⁶ Furthermore, plastics can severely affect the health of fish populations, directly impacting individuals whose diet and economy depend on fishing.^{5,6}

Some of the health effects of climate change are easily now detectable. Their risk and intensity will increase proportionally with the magnitude of climate change. In fact, it has been postulated that the elimination of fossil fuel utilization would prevent approximately 3.6 million premature deaths per year globally from air pollution.^{7,8}

Additional effects of climate change and their repercussions on human health include:⁹

- Temperature extremes: Higher incidence of heat-related deaths and medical visits for cardiovascular (CV), kidney and respiratory disorders
- Floods: Increased drowning deaths and higher exposures to mold and waterborne diseases
- Wildfires: Poor air quality increases respiratory and CV issues such as asthma and chronic obstructive pulmonary disease (COPD)

- Air pollution: Exposure to particulate matter and ozone increases hospitalizations and deaths due to respiratory diseases such as asthma
- Allergens and pollen: Longer growing seasons produce more pollen and increased incidence of allergies

Ocular manifestations of climate change include:¹⁰

- Increase in UV-radiation-related pathology (pterygium, cataract, age-related macular degeneration (AMD), intraocular and extraocular melanomas, carcinomas)
- Increase in allergies and ocular surface disease from air contaminants
- Increase in malnutrition-related eye disease from devastation of our ecosystems and difficulty in obtaining food
- Increase in waterborne illness (pseudomonas, acanthamoeba)
- Increase in traumatic eye injuries and burns caused by natural disasters and fires

Ophthalmic Surgery and Climate Change

The healthcare sector is responsible for approximately 5% of Canadian greenhouse gas emissions. Although carbon dioxide is by far the largest emission by mass in Canada, our healthcare system also generates life cycle emissions of more than 210,000 metric tonnes of pollutant emissions (other than CO₂). These air, water and soil pollutants can be hazardous to humans.^{11,12}

Cataract surgery is among the most common procedures performed worldwide. Morris et al reported that phacoemulsification performed in the United Kingdom can produce a staggering 182 kg of CO₂ equivalents (KgCO₂e) in the form of plastic waste per eye, which is comparable to driving an automobile for 500 km.¹³ Plastic waste in cataract surgery is a significant problem that needs to be addressed.

Perhaps we must reconsider the paradigm that this excessive waste production is justified by reduced infection rates. Current evidence suggests that excessively wasteful practices do not reduce endophthalmitis rates. In 2019, the Aravind Eye Hospital demonstrated that simply by using intracameral moxifloxacin, their endophthalmitis rates declined to 0.04%,¹⁴ the same rate reported in the United States IRIS registry during the same period (2011–2018). However, there is a significant difference between the two settings: the Aravind Eye Hospital re-used, re-sterilized and re-purposed

so many of their “single use” supplies (e.g., saline bottles, blades, cannulas, gloves, surgical gowns, and gloves) that they were able to provide 60% of the two million surgeries reported for free, to those in need. In fact, if the Aravind Eye Hospital were to dispose all supplies after every case (as we commonly do in Canada), the emissions from each of their surgeries would be equivalent to 13 of their current surgeries.¹⁵ The necessary question is: What evidence is there to support that full body drapes, changing gowns, gloves, phacoemulsification tips, and fluidics hoses/cassettes decrease our endophthalmitis rates? Unfortunately, there is no such data. These practices are traditions passed on to us by previous generations; they are habits adopted and sanctified at a time when the concept of evidence-based medicine (EBM) was unknown. We have been practicing “eminence-based medicine” at the cost of our environment’s health and without true proven benefit to our patients. This practice of overaction in the name of safety has been termed “defensive medicine” and, unfortunately, it increases the cost per case and worsens the environmental impact of our procedures without improving outcomes.¹⁶

We need to start making decisions about safety and consider our impact on the environment based on evidence, not eminence. As some cynics have stated: clinical experience can be described as “making the same mistakes with increasing confidence over an impressive number of years.”¹⁷

Is the Ophthalmology Sector Concerned?

Actually, ophthalmologists and nurses do care. According to a survey published by Chang et al in 2020,¹⁸ the vast majority of ophthalmologists (90%) are concerned about global warming, feel that operating room (OR) waste is excessive, and wish there were more reusable options. In fact, if given the choice, ten times more surgeons would prefer a reusable product over a disposable one. Furthermore, there was a strong consensus regarding the need for manufacturers to reduce their carbon footprint with more environmentally conscious packaging and by modifying the “single use” labels to allow for surgeon discretion in deciding the lifespan of some products. This included ophthalmic drops, intraocular solutions, phacoemulsification and irrigation/aspiration tips, cassettes, and cannulas. Furthermore, most respondents reported that they wanted their medical societies to advocate for sustainability.

What Steps can be Taken?

Education

A significant change to our current approach is required in order to shift the direction in which we are headed. This should encompass a combination of widespread, small scale, individual changes and large-scale industry standards modifications, coupled with updated legislations issued by regulatory bodies.

Healthcare professionals (HCPs) must re-define the status quo, and research is the tool for this to occur. One example of this is the research by Mamalis et al, which showed that phacoemulsification tips are not ultra-structurally affected by multiple re-sterilization cycles.¹⁹ Exploring the situation in less developed countries where expense reduction is obligatory may be a good way to study outcomes and safety, such as with the Aravind Eye Hospital. In fact, during the COVID-19 pandemic, the Hospital was forced to “regress” to the model that we currently use in North America (including excessive personal protection equipment [PPE], disposables, changing gloves). Interestingly, their infection rates did not decrease during this time.²⁰

Educating ourselves, our peers and our policy-makers is fundamental. The author recommends joining [Eyesustain.org](https://eyesustain.org), an organization endorsed by the American Academy of Ophthalmology (AAO), and the American and European Societies of Cataract and Refractive Surgeons (ASCRS and ESCRS). Their website contains numerous resources to support HCPs in making a change today. Start by calculating your OR’s carbon footprint and modify your protocols and materials accordingly (<https://eyesustain.org/topics/sustainability-in-the-operating-room/carbon-footprint-calculator>). Reduce your custom cataract pack by requesting that they include only the essential items (eliminate excess cannulas, syringes, balanced salt solution [BSS] bottles). Not only is this practice sustainable, but it will also actually result in a cost saving for your institution. Re-purpose everything that was not used or did not come into contact with patients. The author sets aside any extra drapes, containers and disposable towels, and encourages staff to bring them home, extending their lifespan beyond the trash can.

Engage with your hospital management and encourage them to adopt more sustainable practices and materials. The Eyesustain.org library contains many articles that can be referred to when engaging

hospital committees and provincial or national regulatory bodies. Educate yourself and spread the knowledge with everyone around you. Contribute to the growing body of evidence by publishing your own results. Raise the sustainability conversation at your next ophthalmology meeting, regardless of its size. Encourage the organizing committees of ophthalmology meetings to increase the meeting content related to sustainability at their events. Additionally, consider choosing your in-person meetings wisely: A single scientist's carbon footprint can be as high as 2–5 tonnes of CO₂ per meeting (attributable to congress-related emissions such as travel, hotels, catering, event disposable materials, promotional materials, etc.).²¹ We learned a tremendous amount about emissions and virtual meetings during the COVID-19 pandemic, it is now time to apply this knowledge.

Strength in Numbers

At some point we all need to become more involved. Large-scale change requires us to act as a group, especially when it comes to confronting the ophthalmic industry about unsustainable practices (e.g., packaging, shipping, labelling), and governments about policies and regulations that lack scientific evidence to support them. We must pressure the industry to increase the adoption of reusable packaging and industrially compostable plastic packaging for targeted applications, as well as reusable options. Governments should be encouraged to reduce the leakage of plastics into the

environment. Moreover, manufacturers must be made accountable for after-use collection and reprocessing, particularly of products with high leak potential.⁴

Personal and Professional Responsibility

Life exists outside the OR, as does sustainability. As we become aware of our carbon footprint in healthcare facilities, it is important that we evaluate our personal lives with the same scientific rigour that we employ at work and ask ourselves what more (or less) can we do for our planet.

For education and excellent advice on more sustainable living, visit the United Nation's website and download their [ActNow app](#), which provides a guide for living sustainably and empowering individuals to take action against climate change.

Summary

Climate change is a very real phenomenon and we have reached a critical point in time. Healthcare is a major contributor to emissions and climate change. We have a commitment to care for the wellbeing of humanity; this includes taking care of the environment in which we all live and on which we all depend. Most importantly, what we do today will determine our children's future. Action is required today; tomorrow will be too late.

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