Asia-Pacific Journal of Ophthalmology 14 (2025) 100243

Contents lists available at ScienceDirect

Asia-Pacific Journal of Ophthalmology

journal homepage: www.sciencedirect.com/journal/asia-pacific-journal-of-ophthalmology

APAO survey of cataract surgeons' attitudes toward operating room waste

David F. Chang [a,*], Wendy See [b]

[a] Private practice, Los Altos, CA, USA
[b] Department of ophthalmology, Sarawak General Hospital, Kuching, Malaysia

ARTICLE INFO

Keywords:
Sustainability
Surgical waste
Multiuse supplies

ABSTRACT

Purpose: To determine Asia Pacific cataract surgeons' attitudes toward surgical waste and toward reusing supplies and pharmaceuticals.
Design: Multinational survey of APAO members
Methods: An online survey link was distributed to APAO members through their national ophthalmology societies. Responses were deidentified and compared with those from identical survey questionnaires previously distributed to North American and European cataract surgeons.
Results: Of 2095 total respondents, most were concerned about climate change (94 %), felt cataract surgical waste was excessive (96 %), and felt we should reduce unnecessary waste by safely reusing more surgical supplies and devices (80 %). Most identified manufacturers and regulatory agencies as the biggest drivers of single use products, rather than surgeons and patients. Most surgeons wanted more reusable instruments and supplies (92 %) and wanted greater discretion from manufacturers (92 %) andpolicymakers (90 %) to reuse many supplies, drugs, and devices; 89 % wanted their medical societies to advocate for reducing the waste and carbon footprint of cataract surgery.
Far more APAO respondents (59 %) were currently reusing single-use instruments compared to North Americans (7 %) and Europeans (14 %). Many APAO respondents were currently reusing phacoemulsification tubing/cassettes (41 %), irrigation solution bottles (50 %), and intraocular drug solutions (41–55 %); 42 % were currently not changing surgical gowns between cases. These percentages were all higher compared to North American and European respondents.
Conclusions: These universal and consensus opinions and preferences about willingness to reuse many cataract surgical products should inform and influence pharmaceutical and supply manufacturers, governmental policy makers, and health care institutions, such as hospitals and surgical facilities.

Introduction

Both The Lancet Climate Change Commission and the World Health Organization have declared climate change a major global health threat.[1,2] The increased burden of disease from weather extremes, air pollution, and food and water insecurity is disproportionately borne by the poorest populations in communities where resources and access to health care are already constrained. Paradoxically, the healthcare sector is further fueling the climate crisis by contributing nearly 5 % of all global greenhouse gas (GHG). According to Healthcare Without Harm, if the global healthcare sector was a hypothetical country, it would rank as the fifth largest GHG emitter in the world.[3] The manufacture, use, and disposal of supplies is responsible for over 70 % of this carbon footprint, with operating rooms (OR) accounting for a major share.[4] In addition to GHG, the harmful health impact of non-degradable micro- and nano-plastics that pollute our environment is increasingly recognized.[5,6] Worldwide, approximately 30 % of healthcare waste is plastic; most is not recycled due to contamination risks and instead ends up in incinerators, landfills, or natural environments. Cataract surgery is already one of the most common surgical procedure performed worldwide, and this volume is projected to rise considerably because of expanding and aging populations. Ophthalmology therefore has a compelling opportunity and obligation to lead efforts to advance sustainability within medicine.[7]

The first major survey of cataract surgeons' attitudes toward surgical waste was conducted by the Ophthalmic Instrument Cleaning and Sterilization (OICS) task force and published in 2020.[8] Co-chaired by one of the authors (DFC), this multisociety North American task force

* Correspondence to: 762 Altos Oaks Drive, Los Altos, CA 94024, USA.
E-mail address: dceye@earthlink.net (D.F. Chang).

https://doi.org/10.1016/j.apjo.2025.100243
Received 11 August 2025; Received in revised form 29 August 2025; Accepted 2 September 2025
Available online 5 September 2025

polled members of the American Society of Cataract and Refractive Surgery (ASCRS), the American Academy of Ophthalmology (AAO), the Outpatient Ophthalmic Surgery Society (OOSS) and the Canadian Ophthalmological Society (COS). Members of the European Society of Cataract and Refractive Surgeons (ESCRS) were subsequently surveyed using the same online questionnaire developed by the OICS task force.[9] Respondents to these surveys were predominantly from the United States (US) (86 %) or Europe (77 %), respectively. Both surveys found strong consensus among cataract surgeons that surgical waste was excessive, that manufacturers should develop and provide more reusable supply options, and that policymakers should allow surgeons more discretion to reuse devices and supplies.

In both the US and the European Union markets, manufacturers must obtain approval of devices, pharmaceuticals, and surgical supplies through a single regulatory agency. In terms of ophthalmology regulations and governance, the Asia-Pacific is a more heterogeneous region with differing national policies and regulatory agencies among major markets, such as China, Japan, India, South Korea, and Australia/New Zealand. For this reason, we surveyed members of the Asia-Pacific Academy of Ophthalmology (APAO) regarding their opinions pertaining to cataract surgical waste and their reuse practice patterns. To facilitate comparisons of the results to North American and European ophthalmologists, we used the same online questionnaire from the OICS and ESCRS surveys.[8,9]

Methods

The identical questionnaire used for the prior OICS and ESCRS surveys was used with minor modifications to account for the Asia-Pacific region. The survey consisted of 20 multiple choice questions, the first 5 of which were demographic. Respondents could complete the survey online after receiving the link by email. The Asia-Pacific Academy of Ophthalmology (APAO) is a federation of national/territorial ophthalmic societies and regional sub-specialty organizations. On February 24, 2025, APAO invited the leadership of these national/territorial societies to distribute a web link to the online survey to their respective members,. In some cases, follow up email requests were sent. However, it was not possible to determine how many individuals received the link or to confirm whether and how every society chose to distribute this survey link. Because the survey link was shared at different times, the online survey was kept open until July 1, 2025, to accommodate one society which distributed the survey link in June.

The survey was presented in three languages - English, Chinese, and Japanese – which respondents could select upon opening the survey link. Duplicate responses were prevented by requiring a name and email address for access to the survey and allowing only one submission for each email address. Respondents were asked to complete the survey only if they performed cataract surgery. Responses were deidentified for analysis. The APAO responses were compared with those from the prior OICS and ESCRS surveys.

Results

Demographics

A total of 2172 respondents answered at least some clinical survey questions. Of these, 1803 respondents completed the entire survey. The distribution of respondent nationality is displayed in Fig. 1, and other demographic information is listed in Table 1. All tables display the APAO survey results, alongside those from the earlier OICS and ESCRS surveys. Most respondents were male (61 %) and had been in practice for more than 10 years (72 %); 30 % were higher volume surgeons (>500 cases/year). This was similar to the OICS and ESCRS survey demographics.

Opinions regarding surgical waste

Among 2095 total APAO respondents, most (94 %) were concerned about global warming and climate change; 59 % were “very concerned” and 6 % were “not concerned”. This mirrored North American and European respondents who were respectively 91 % and 99 % concerned, 59 % and 72 % very concerned, and 8 % and 1 % unconcerned. In both prior surveys, 96 % felt that we should seek ways to reduce waste in cataract surgery. Most (86 %) felt reducing surgical waste is important and 80 % felt we should seek more ways to safely reuse surgical supplies and instruments. Only 5 % felt that there was no need to change what we

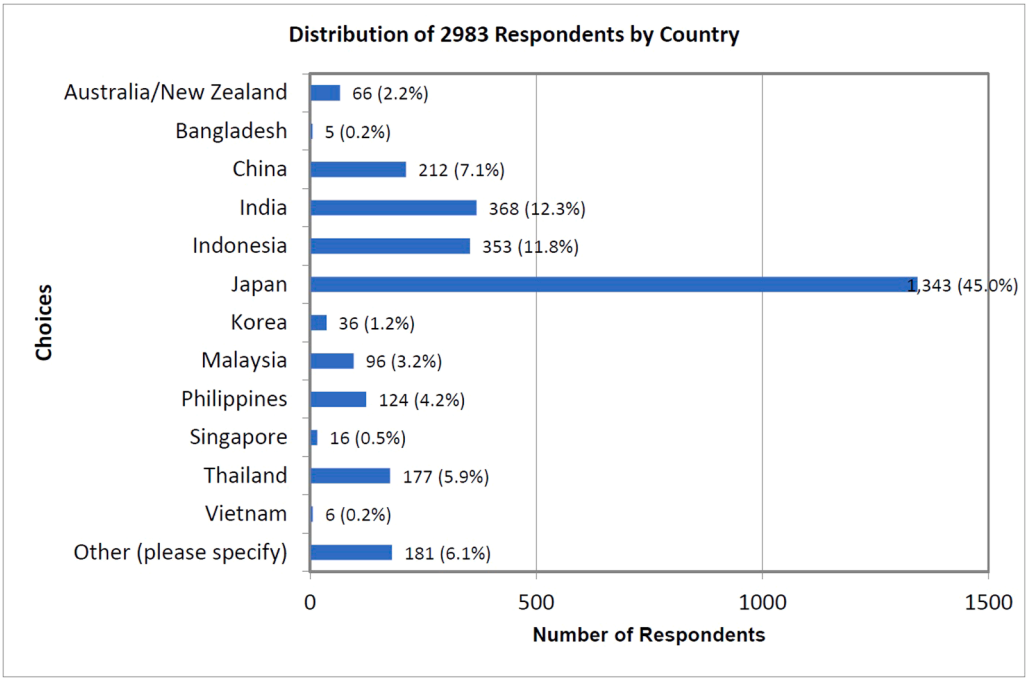

Fig. 1. Distribution of survey respondents by country.

Table 1
APAO survey respondent demographics (Comparison to OICS/ESCRS survey respondents shown in parentheses).

Operating Facility Type	**Public or Government Hospital**	**Private Hospital or Center**	**Freestanding ASC* (multispecialty)**	**Freestanding ASC (ophthalmology only)**	**Other**
Respondents: n = 3065	38 %	30 %	2 %	6 %	23 %
Gender	**Female**	**Male**	**Not Answered**		
Respondents: n = 3068 (1246/421)	38 % (35/30 %)	61 % (62/69 %)	1 % (0/1 %)		
Years in practice	Currently in Training	1–5 years	6–10 years	11–25 years	> 25 years
Respondents: n = 3068 (1063/428)	5 % (5/5 %)	11 % (14/12 %)	12 % (16/13 %)	37 % (40/38 %)	35 % (25/32 %)
Average annual # cataract surgeries	< 200	200 – 500	501–1000	> 1000	
Respondents: n = 3066 (1058/433)	32 % (18/18 %)	38 % (44/43 %)	16 % (26/28 %)	14 % (12/11 %)	

* ASC – ambulatory surgical center

do.

Table 2 presents what respondents felt were the leading drivers generating excessive OR waste and trash. The most frequently cited high impact factors were manufacturers driving the market towards more profitable single use products (72 %), manufacturers mandating single use to limit liability (71 %), single use items packaged in ways that create unnecessary waste (66 %), regulatory agencies limiting surgeon discretion for reusing supplies (66 %), and lack of environmental/carbon footprint considerations (63 %). These same factors were similarly highlighted by North American and European surgeons. Surgeon preference for single-use items (53 %), performance benefits of single-use items (47 %), and patient preference for single-use instruments (33 %) were less often cited as high impact drivers but were rated relatively higher by APAO respondents, compared to North Americans and Europeans.

In terms of general strategies to reduce surgical waste (Table 3), at least 90 % of APAO respondents wanted manufacturers to offer more reusable instruments and supplies and to consider environmental impact in their product design, while allowing (along with regulatory bodies) more surgeon discretion in reusing products.

Table 2
Drivers of operating room waste. (Comparison to OICS& ESCRS survey respondents shown in parentheses).

How would you rate the impact of each of the following as drivers of waste/trash generation in ophthalmic operating rooms? APAO (OICS/ESCRS)			
APAO n = 2172 (OICS / ESCRS n = 1101 / 334)	**High impact**	**Moderate impact**	**Little or no impact**
Perceived safety benefits of disposable items	60 % (74/71 %)	33 % (22/26 %)	7 % (4/3 %)
Perceived performance benefits of disposable items	47 % (33/40 %)	42 % (44/44 %)	11 % (24/15 %)
Surgeon preference for single use items	53 % (26/42 %)	39 % (45/40 %)	9 % (28/18 %)
Surgeons do not reuse supplies when possible	59 % (33/41 %)	32 % (37/41 %)	9 % (30/18 %)
Surgical teams open too many supplies during surgery	59 % (37/38 %)	31 % (39/38 %)	10 % (24/24 %)
Single use items packaged in ways that create unnecessary waste	66 % (71/70 %)	29 % (24/26 %)	5 % (5/4 %)
Hospital/facility policies limit surgeon discretion for reusing supplies	59 % (74/58 %)	34 % (21/36 %)	7 % (5/6 %)
Regulatory agencies limit surgeon discretion for reusing supplies	66 % (82/65 %)	29 % (15/28 %)	5 % (3/7 %)
Patients want single use instruments	33 % (7/17 %)	34 % (19/23 %)	33 % (74/60 %)
Manufacturers mandate single use IFU* (instruction for use) to limit liability	71 % (70/67 %)	25 % (26/27 %)	4 % (4/6 %)
Manufacturers drive the market towards more profitable single use products	72 % (77/74 %)	24 % (20/24 %)	4 % (3/1 %)
Lack of environmental/carbon footprint considerations	63 % (65/73 %)	31 % (26/23 %)	6 % (10/4 %)

In your opinion, what are the primary drivers for single use INSTRUMENTS in ophthalmic surgery? APAO (OICS/ESCRS)			
APAO n = 1812 (OICS / ESCRS n = 1013 / 302)	Major factor	Minor factor	Not a factor
Instrument performance	69 % (38/47 %)	23 % (42/35 %)	8 % (20/18 %)
Liability reduction	59 % (66/50 %)	34 % (26/36 %)	7 % (8/14 %)
Patient safety	81 % (49/64 %)	15 % (40/25 %)	4 % (12/11 %)
Staff safety	49 % (16/26 %)	36 % (48/36 %)	15 % (36/38 %)
Patient desirability or preference	24 % (6/10 %)	38 % (29/28 %)	38 % (65/61 %)
Cost savings to hospital/facility	51 % (26/41 %)	34 % (36/34 %)	15 % (39/26 %)
Reduced staff processing requirements (e.g., cleaning and sterilization)	51 % (45/55 %)	41 % (45/38 %)	8 % (10/8 %)
Improved OR efficiency	56 % (37/45 %)	35 % (47/42 %)	9 % (16/13 %)
Lack of environmental/carbon footprint considerations	44 % (40/53 %)	42 % (28/30 %)	14 % (32/17 %)
Manufacturer profit	37 % (62/50 %)	28 % (20/27 %)	35 % (18/23 %)
Easier regulatory approval pathway	54 % (65/48 %)	35 % (26/40 %)	11 % (9/12 %)

* IFU – instructions for use

Table 3
Global strategies to reduce waste. (Comparison to OICS & ESCRS survey respondents shown in parentheses).

	To what extent do you agree or disagree with the following? APAO (OICS/ESCRS)				
APAO n = 2169 (OICS / ESCRS n = 1101 / 336)	**Strongly agree**	**Somewhat agree**	**Neither agree nor disagree**	**Somewhat disagree**	**Strongly disagree**
Device and supply manufacturers should consider the environment/carbon footprint in their product design.	65 % (76/85 %)	25 % (16/10 %)	8 % (5/3 %)	1 % (1/0 %)	1 % (1/1 %)
Manufacturers should offer more reusable instruments and supplies as an option.	65 % (81/74 %)	27 % (13/18 %)	6 % (5/5 %)	1 % (1/1 %)	1 % (0/1 %)
Device and supply manufacturers should allow surgeons more discretion in their IFU* (e.g. suggest single use but allow reuse).	66 % (75/60 %)	26 % (18/29 %)	6 % (5/5 %)	1 % (2/4 %)	1 % (1/1 %)
Regulatory bodies should allow surgeons more discretion in reusing supplies, drugs, and devices.	65 % (81/64 %)	25 % (14/25 %)	7 % (3/6 %)	2 % (1/4 %)	1 % (0/1 %)
My medical societies should advocate for the reduction of carbon footprint in operating rooms.	66 % (71/79 %)	23 % (16/15 %)	8 % (7/4 %)	2 % (3/1 %)	1 % (3/1 %)
We need more studies to assess the safety of reuse of supplies, drugs, and devices.	63 % (68/67 %)	24 % (19/19 %)	9 % (7/10 %)	2 % (3/2 %)	2 % (2/2 %)

* IFU – instructions for use

Opinions regarding the reuse of surgical products, pharmaceuticals, and instruments

Patient safety (81 %) was the most frequently selected major factor driving preference for single use instruments, followed by instrument performance (69 %) (Table 2). European surgeons also cited patient safety most often (64 %). North American surgeons most frequently cited liability reduction (66 %) easier regulatory approval (65 %), and manufacturer profit (62 %). Patient preference was listed least often in all three surveys.

Mirroring the OICS and ESCRS survey respondents, most APAO respondents were either reusing or willing to reuse topical and intraocular pharmaceuticals (Table 4). Drugs that were currently being used as multidose by at least half the respondents included topical mydriatics (69 %), anesthetic (68 %), and antibiotics (50 %), and intraocular lidocaine (55 %), alpha-agonists (54 %), and capsular dye (52 %). Table 4 also reports on the reuse of many surgical supply items. Most APAO respondents were willing to reuse phacoemulsification and irrigation/aspiration (IA) tips (93 %), phacoemulsification/IA tubing (81 %), bottles or bags of irrigation solution (80 %), and metal blades (55 %).

APAO, OICS, and ESCRS survey respondents were similar in their ranking of factors affecting their willingness to reuse supplies and medications on multiple patients (Table 5). As major factors, endophthalmitis risk was listed by 40 % and malpractice liability by 38 % (compared to 51 % in North America). Major factors affecting willingness to reuse single-use supplies and devices off label in decreasing order of frequency were safety risk (76 %), performance (69 %), cost (66 %), and facility regulations (58 %). The latter was a major factor for 72 % in North America. Reducing environmental footprint was a major factor for only 50 %, compared to 79 % in Europe.

Table 6 shows that APAO respondents had already or would consider adopting a variety of waste-reducing strategies. In declining order of interest, this includes reusing single use instruments (82 %), eliminating the full-body drape (81 %), short-cycle autoclave sterilization (77 %), not changing surgical gowns between every case (70 %), immediate sequential bilateral cataract surgery (62 %), and not changing patients into hospital gowns (59 %).

Discussion

Using an identical survey methodology and questionnaire to compare Asian Pacific, North American, and European cataract surgeons, we found that general opinions about surgical waste were strikingly similar worldwide. There was a strong consensus that OR waste from cataract surgery is excessive and that many supplies, drugs, and devices could be safely reused rather than discarded after a single use. That these opinions and preferences are universally held should inform and influence pharmaceutical and supply manufacturers, governmental policy makers, and health care institutions, such as hospitals and surgical facilities.

As with their North American and European counterparts, most Asian Pacific surgeons preferred having more reusable supply and device options (Table 3). If of equal cost and functionality, 66 % of APAO surgeons preferred reusable instruments and only 21 % preferred disposable instruments. Mirroring the OICS and ESCRS survey responses, these results contradict the premise that most surgeons prefer single-use instrumentation and supplies. APAO respondents shared their North American and European colleagues' opinions that much OR waste is driven by manufacturers specifying single use to limit liability (96 %), drive profitability (96 %), and facilitate regulatory approval (89 %). They wanted manufacturers to offer more reusable instruments and supplies (92 %), more discretion for reuse in their instructions for use (IFU) (92 %), and to improve the carbon footprint of their product design and packaging (90 %). As an example,

Table 4
Willingness to use products on multiple patients. (Comparison to OICS & ESCRS survey respondents shown in parentheses).

Rate your willingness to use the following on MULTIPLE PATIENTS in cataract surgery APAO (OICS/ESCRS)				
Topical Pharmaceuticals from Bottles (multidose)				
APAO n = 1920 (OICS / ESCRS n = 1044 / 326)	**Currently use as multidose**	**Willing to consider multidose use**	**Unwilling to multidose**	**Unsure**
Mydriatics	69 % (48/43 %)	18 % (51/48 %)	11 % (1/7 %)	2 % (1/2 %)
Antibiotics	50 % (45/43 %)	21 % (53/43 %)	25 % (1/10 %)	4 % (1/4 %)
NSAIDs	40 % (38/34 %)	23 % (59/52 %)	26 % (1/9 %)	11 % (2/5 %)
Anesthetic	68 % (43/42 %)	18 % (55/48 %)	12 % (1/7 %)	2 % (1/2 %)
IOP lowering meds	33 % (42/32 %)	23 % (55/55 %)	29 % (1/10 %)	15 % (1/3 %)
Intraocular Pharmaceuticals				
APAO n = 1924 (OICS / ESCRS n = 1050 / 326)	**Currently use as multidose**	**Willing to consider multidose use**	**Unwilling to multidose**	**Unsure**
Antibiotics	41 % (32/48 %)	25 % (63/39 %)	24 % (3/10 %)	10 % (2/3 %)
Alpha-agonists/mydriatics	54 % (34/33 %)	22 % (61/50 %)	17 % (2/13 %)	7 % (3/3 %)
Miotics	43 % (20/28 %)	23 % (73/53 %)	23 % (3/15 %)	11 % (2/5 %)
Lidocaine	55 % (30/39 %)	21 % (65/45 %)	16 % (3/12 %)	8 % (2/4 %)
Capsular dye	52 % (10/21 %)	23 % (80/53 %)	19 % (7/20 %)	6 % (3/6 %)
Corticosteroids (e.g. triamcinolone)	31 % (16/21 %)	28 % (76/55 %)	28 % (4/18 %)	13 % (4/7 %)
Commercially packaged solutions (in general)	29 % (11/19 %)	28 % (84/61 %)	22 % (3/12 %)	21 % (2/7 %)
Compounded solutions (in general)	28 % (12/15 %)	27 % (74/60 %)	26 % (7/15 %)	19 % (7/10 %)
Solutions mixed by OR nurse (in general)	35 % (15/23 %)	24 % (67/47 %)	25 % (10/22 %)	16 % (8/9 %)
Supply Items (if appropriately cleaned and sterilized)				
APAO n = 1929 (OICS / ESCRS n = 1070 / 332)	**Currently reuse**	**Willing to consider reuse**	**Unwilling to reuse**	**Unsure**
Phaco tips	68 % (38/48 %)	25 % (54/42 %)	6 % (5/8 %)	1 % (3/2 %)
IA tips	73 % (41/48 %)	20 % (49/40 %)	6 % (6/9 %)	1 % (4/3 %)
Phaco and IA tubing	41 % (7/21 %)	40 % (69/55 %)	16 % (17/17 %)	3 % (7/8 %)
irrigating solution/bottle (i.e., use open bottles for more than one patient)	50 % (8/26 %)	30 % (70/47 %)	18 % (15/21 %)	2 % (6/7 %)
Small gauge cannulas	35 % (27/18 %)	17 % (47/38 %)	43 % (21/36 %)	5 % (6/8 %)
Metal blades	20 % (14/18 %)	25 % (64/43 %)	53 % (18/31 %)	2 % (4/8 %)
Non-metal surgical devices (iris and capsule retractors, pupil expansion rings)	29 % (9/16 %)	34 % (63/48 %)	33 % (20/27 %)	4 % (8/9 %)

a multisociety position paper was published in 2023 calling for industry and the agencies regulating devices to abolish paper IFU for eye surgical products in favor of electronic IFU.[10]

Surgical pharmaceutical waste accounts for significant resource consumption, waste generation, carbon emissions, and cost, and can exacerbate drug shortages. A 2019 study estimated that drug wastage from cataract surgery costs approximately US$150 per case and generated 23,000–105,000 metric tons of unnecessary CO_2eq emissions annually in the US.[11] Most APAO members were willing to consider multidosing both topical and intraocular pharmaceuticals for cataract surgery. Compared to the OICS and ESCRS surveys, there were more APAO respondents currently multidosing topical and intraocular pharmaceuticals, but also more respondents unwilling to multidose these drugs. This may reflect different country practice patterns across Asia-Pacific, where national and hospital regulations regarding the reuse of surgical drugs may vary widely. The OICS task force and Eye-Sustain published a multisociety position paper on reducing surgical drug waste in 2022.[12] Endorsed by AAO, ASCRS, OOSS, and the American Glaucoma Society, the paper recommended that multidose bottles can be used on multiple patients until the labeled date of expiration and need not be arbitrarily discarded at the end of the day, the week, or the month.

Off-label reuse of single-use surgical supplies and pharmaceuticals is routinely practiced in many settings. This conserves resources and reduces cost, non-recycled waste, GHG emissions, and the risk of supply shortages.[13] Off-label reuse was much more commonly practiced by APAO survey respondents (59 %) than their North American (7 %) or European (14 %) counterparts (Table 6). Similar percentages of respondents from each region were either willing or unwilling to consider this practice; this suggests that differing regulatory restrictions on off-label reuse were a major factor in this disparity. For example, far more APAO surgeons (41 %) were currently reusing phacoemulsification/IA tubing compared to North Americans (7 %) and Europeans (21 %). This was also true of those currently reusing irrigating solution containers (50 % vs 8 %/26 %). This may reflect differences in the ability to reuse single-use products off label, or greater availability of reusable phacoemulsification cassettes in some regions.

Data on postoperative endophthalmitis (POE) rate associated with reuse of cataract surgical supplies and drugs has been published by one institution, the Aravind Eye Care System (AECS) in southern India.[14] This network of 15 regional surgical facilities annually performs approximately 450,000 cataract surgeries with standardized protocols that include routine reuse of perioperative topical and intraocular medications, surgical gowns, and many of the supplies listed in Table 5. Because procurement of surgical supplies and pharmaceuticals accounts for the highest percentage of the carbon footprint of cataract surgery, a single phacoemulsification procedure at Aravind generates 1/20th the carbon emissions of a single phacoemulsification in the United Kingdom.[15] In 2019, Aravind reported a 0.01 % POE rate while using these reuse protocols in 335,000 consecutive phacoemulsification procedures.[14] A more recent analysis found the identical 0.01 % POE rate in 1,133,959 consecutive phacoemulsification procedures performed at AECS between 2016 and 2024.[16] This is lower than the 0.06 % POE rate reported from the AAO Intelligent Research in Sight Registry (IRIS) between 2013 and 2023.[17]

Beyond its carbon footprint, the phacoemulsification cassette with tubing is a particularly important source of waste because the non-recyclable plastic ends up in landfill. A life cycle analysis determined that the carbon footprint of 1000 single-use cassettes with packaging was 725 kg CO2eq, equivalent to driving a car 2840 km (1764 miles).[18]

Table 5
Factors affecting willingness to use products on multiple patients. (Comparison to OICS & ESCRS survey respondents shown in parentheses).

To what extent do the following factors DECREASE your willingness to use supplies and medications on MULTIPLE PATIENTS APAO (OICS/ESCRS)			
APAO n = 1913 (OICS / ESCRS n = 1037 / 321)	**Significant impact**	**Some impact**	**No impact**
Endophthalmitis risk	40 % (48/64 %)	40 % (38/26 %)	20 % (15/9 %)
TASS* risk	28 % (43/40 %)	42 % (39/43 %)	30 % (18/17 %)
Concern over staff safety	21 % (11/18 %)	48 % (37/38 %)	31 % (52/44 %)
Decreased efficiency	16 % (7/13 %)	40 % (31/36 %)	44 % (62/50 %)
Malpractice liability	38 % (51/41 %)	44 % (38/41 %)	18 % (11/18 %)
To what extent do the following factors INCREASE your willingness to use supplies and medications on MULTIPLE PATIENTS APAO (OICS/ESCRS)			
APAO n = 1913 (OICS / ESCRS n = 1026 / 313)	**Significant impact**	**Some impact**	**No impact**
Cost savings	53 % (63/47 %)	40 % (35*46 %)	7 % (2/7 %)
Reduced carbon footprint & waste	55 % (66/73 %)	39 % (27/23 %)	6 % (7/4 %)
Improved efficiency	46 % (63/49 %)	44 % (33/37 %)	10 % (4/14 %)
To what extent do the following factors affect your willingness to reuse single-use medical supplies and devices? APAO (OICS/ESCRS)			
APAO n = 1803 (OICS / ESCRS n = 1009 / 301)	**Major factor**	**Minor factor**	**Not significant**
Cost	66 % (59/56 %)	28 % (33/39 %)	6 % (8/6 %)
Safety risk	76 % (72/78 %)	20 % (22/18 %)	4 % (6/4 %)
Performance of the item	69 % (79/77 %)	25 % (18/21 %)	6 % (3/2 %)
Facility regulations	58 % (72/55 %)	34 % (24/37 %)	8 % (5/8 %)
Patient perception	32 % (16/12 %)	41 % (44/52 %)	27 % (39/35 %)
Environmental/carbon footprint considerations	50 % (58/79 %)	40 % (30/18 %)	10 % (12/3 %)

* TASS – Toxic anterior segment syndrome

This would generate 239 kg (527 lbs) of waste, 85 % of which is plastic. An autoclavable multiuse cassette approved for 20 uses with the same phacoemulsification machine would reduce the carbon footprint and plastic waste by 20-fold. The closed phacoemulsification fluidic system contains sterile aqueous, lens material, ophthalmic viscosurgical device, and irrigation fluid, raising the question of whether it is necessary to discard the cassette after every case. AECS routinely reuses a single-use phacoemulsification cassette/tubing set continuously for the entire surgical day.[16,19] Approximately 20–25 consecutive cases are completed without changing the cassette, and the irrigation container is also used continuously until it is nearly empty. In one AECS study, 370 cultures taken from the continually reused phacoemulsification tubing or of residual irrigation fluid from containers continuously used on multiple patients were all negative.[19]

Some operating room protocols developed for general surgery may not be necessary or appropriate for cataract surgery, where the risk of cross contamination with soiled body fluids or tissue is extremely low.[13] A retrospective study at AECS found that not changing surgical gowns and gloves after every case, not having patients wear hospital gowns over their clothing, not cleaning the OR floor and surfaces after every case, and operating on multiple patients simultaneously in the same OR did not result in a higher rate of POE.[20] Reuse of surgical gowns was much higher among APAO cataract surgeons (42 %) compared to those in North America (4 %) or Europe (10 %) (Table 6). APAO respondents were also more likely to have eliminated full-body draping and to perform immediately sequential bilateral cataract surgery (ISBCS) (31 % vs 8 %/14 %). ISBCS significantly reduces carbon emissions associated with patient travel.[21] APAO respondents were more likely to have been using short-cycle autoclave cycles (33 %), but a larger number (44 %) were not, despite expressing willingness to do so (Table 6). This may reflect that general surgery guidelines often discourage use of shorter flash sterilization cycles.[13] In 2018, the OICS task force published evidence-based, ophthalmology specific guidelines for surgical instrument cleaning and sterilization that defended short-cycle steam sterilization for sequential same day cases.[22]

Surveys are subject to bias based on which individuals are willing to

Table 6
Willingness to adopt waste-reducing practices. (Comparison to OICS & ESCRS survey respondents shown in parentheses).

What is your willingness to do the following in cataract surgery? APAO (OICS/ESCRS)				
APAO n = 1814 (OICS / ESCRS n = 1031 / 315)	**Currently done**	**Willing to consider**	**Unwilling to consider**	**Unsure**
Eliminate a full-body drape (use a face drape only)	57 % (44/47 %)	24 % (51/41 %)	15 % (4/10 %)	4 % (1/3 %)
Do not change the patient into hospital gown (patient stays in own clothing)	34 % (56/50 %)	25 % (34/27 %)	36 % (7/19 %)	5 % (3/4 %)
Do not change surgical gowns between every case (surgeon and scrub nurse)	42 % (4/10 %)	28 % (60/45 %)	27 % (28/38 %)	3 % (7/6 %)
Do not change surgical gloves between every case	6 % (1/3 %)	12 % (16/14 %)	79 % (77/75 %)	3 % (7/8 %)
Reprocess and reuse single use instruments from surgeries	59 % (7/14 %)	23 % (84/70 %)	14 % (5/11 %)	4 % (4/5 %)
Use short-cycle, sequential same day sterilization techniques (shortened autoclave cycle)	33 % (26/26 %)	44 % (65/57 %)	19 % (5/10 %)	4 % (5/7 %)
Immediately sequential bilateral cataract surgery	31 % (8/14 %)	31 % (48/45 %)	28 % (34/32 %)	10 % (10/10 %)

spend the time to complete them. In addition, far more Japanese surgeons completed the survey than from any other country, which may relate to the way in which the Japanese Ophthalmology Society distributed the survey link. This could have skewed some results. The response rate from South Korean surgeons was very low, perhaps because the survey was not translated into Korean. Finally, we could not determine the survey response rate, because it was left to the discretion of different APAO national/territorial societies to distribute the survey link. These factors could limit the generalizability of the findings. Because of varying regulations and local practices, country-specific surveys would be of additional interest.

Because POE is potentially blinding, medicolegal concerns undoubtedly influence decision-making in ORs. Indeed, 82 % of APAO survey respondents felt that liability impacted their willingness to reuse supplies and medications on multiple patients; 38 % felt this had significant impact. Clinical recommendations should not be based on survey results which are not a substitute for scientific research. However, surveys may be relevant to subjective considerations of what practices might violate community standards. It is therefore notable that 59 % of APAO respondents were currently reusing single-use devices, 41 % were reusing phacoemulsification/IA tubing, 50 % were reusing opened irrigation solution containers, and 41–55 % were reusing a variety of intraocular drug solutions. The willingness of most surgeons to consider reusing a variety of supplies and pharmaceuticals should also inform manufacturers that newly commercialized multiuse options could have strong global uptake.

Local and national facility regulations may restrict sensible, but off-label waste-reducing practices, such as reuse of single-use surgical products. It is therefore not surprising that the majority of APAO (89 %), OICS (87 %), and ESCRS (94 %) respondents wanted their medical societies to advocate for reducing the environmental impact of ophthalmic surgery. In 2022, the EyeSustain.org website was launched.[13] Co-sponsored by ASCRS, AAO, ESCRS, and EURETINA, EyeSustain is a global coalition of more than 50 eye societies collaborating to make ophthalmic care and surgery more economically and environmentally sustainable through education, innovation, research, and advocacy. APAO and several national and multinational Asia-Pacific organizations are EyeSustain member societies. Current information, guidance, and resources for reducing ophthalmic surgical waste and environmental impact are freely available on this website for the global ophthalmic community to access. This includes a list of 7 recommended practices that surgeons and facilities can immediately adopt to reduce costs and unnecessary waste, along with supporting educational resources.

Altogether, nearly 4000 cataract surgeons worldwide responded to the APAO, OICS, and ESCRS surveys. The results demonstrated that ophthalmologists are concerned about sustainability, want to cut unnecessary cost, waste, and emissions, and want manufacturers and policymakers to remove product and regulatory barriers that currently stymie these efforts. The survey results outline what most ophthalmologists believe should be done and provide a mandate for all stakeholders to partner in ensuring the economic and environmental sustainability of ophthalmic surgery.

Declaration of Competing Interest

None of the authors has any relevant financial conflict of interest to report

Acknowledgements

The authors wish to acknowledge Diane Blanck from the Outpatient Ophthalmic Surgery Society for her logistical support in conducting the online survey, S Kheong Fang MD and Miswan Muiz Mahyudin MD from APAO for reviewing and testing the survey questions, Tetsuro Oshika MD and Ke Yao MD for arranging for the Japanese and Chinese translation of survey questions respectively, Clare Mok and Clement Tham MD for contacting APAO national/territorial societies about the survey, and the leadership of the multiple APAO affiliated societies who arranged to distribute the survey link to their membership. APAO paid an independent survey vendor to conduct the survey.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.apjo.2025.100243.

References

1. Wang H, Horton R. Tackling climate change: the greatest opportunity for global health. -9 *Lancet*. 2015;386:1798. https://doi.org/10.1016/S0140-6736(15)60931-X.
2. World Health Organization. COP29 Special Report on Climate Change and Health. 2024. Available at: https://climate-adapt.eea.europa.eu/en/observatory/new-cop-29-special-report-on-climate-change-and-health Accessed August 2, 2025.
3. Health Care Without Harm: Health Care's Climate Footprint. 2019. Available at: ⟨https://noharm-global.org/documents/health-care-climate-footprint-report⟩ Accessed August 2, 2025.
4. Wu S, Cerceo E. Sustainability initiatives in the operating room. *Jt Comm J Qual Patient Saf*. 2021;47:663–672.
5. Gopinath PM, Parvathi VD, Yoghalakshmi N, et al. Plastic particles in medicine: a systematic review of exposure and effects to human health. *Chemosphere*. 2022;303, 135227. https://doi.org/10.1016/j.chemosphere.2022.135227.
6. Rizan C, Mortimer F, Stancliffe R, Bhutta MF. Plastics in healthcare: time for a re-evaluation. *J R Soc Med*. 2020;113:49–53. https://doi.org/10.1177/0141076819890554.
7. Chang DF. Needless waste and the sustainability of cataract surgery. *Ophthalmology*. 2020;127:1600–1602. https://doi.org/10.1016/j.ophtha.2020.05.002.
8. Chang DF, Thiel CL. Ophthalmic instrument cleaning and sterilization task force. Survey of cataract surgeons' and nurses' attitudes toward operating room waste. *J Cataract Refract Surg*. 2020;46:933–940. https://doi.org/10.1097/j.jcrs.0000000000000267.
9. Chang DF, Elferink S, Nuijts RMMA. Survey of ESCRS members' attitudes toward operating room waste. *J Cataract Refract Surg*. 2023;49:341–347. https://doi.org/10.1097/j.jcrs.0000000000001096.
10. Schehlein EM, Hovanesian J, Shukla AG, Talley Rostov A, Findl O, Chang DF. Reducing ophthalmic surgical waste through electronic instructions for use: a multisociety position paper. *J Cataract Refract Surg*. 2024;50:197–200. https://doi.org/10.1097/j.jcrs.0000000000001381.
11. Tauber J, Chinwuba I, Kleyn D, Rothschild M, Kahn J, Thiel CL. Quantification of the cost and potential environmental effects of unused pharmaceutical products in cataract surgery. *JAMA Ophthalmol*. 2019;137:1156–1163. https://doi.org/10.1001/jamaophthalmol.2019.2901.
12. Palmer DJ, Robin AL, McCabe CM, Chang DF. Ophthalmic instrument cleaning and sterilization task force. Reducing topical drug waste in ophthalmic surgery: multisociety position paper. *J Cataract Refract Surg*. 2022;48:1073–1077. https://doi.org/10.1097/j.jcrs.0000000000000975.
13. Chang DF. Tackling the challenge of needless surgical waste in ophthalmology. *J Cataract Refract Surg*. 2023;49:333–338. https://doi.org/10.1097/j.jcrs.0000000000001175.
14. Haripriya A, Chang DF, Ravindran RD. Endophthalmitis reduction with intracameral moxifloxacin in eyes with and without surgical complications: results from 2 million consecutive cataract surgeries. *J Cataract Refract Surg*. 2019;45:1226–1233. https://doi.org/10.1016/j.jcrs.2019.04.018.
15. Thiel CL, Schehlein E, Ravilla T, et al. Cataract surgery and environmental sustainability: waste and lifecycle assessment of phacoemulsification at a private healthcare facility. *J Cataract Refract Surg*. 2017;43:1391–1398. https://doi.org/10.1016/j.jcrs.2017.08.017.
16. Chang D.F., Haripriya A. Postoperative endophthalmitis rate associated with routine off-label reuse of single-use phacoemulsification cassettes in more than 1,000,000 consecutive surgeries. Submitted to APJO publication.
17. Ghoraba HH, Haque E, Or C, Yu G, Nguyen QD, Pershing S. IRIS® registry (Intelligent Research in Sight) analytic center consortium. Incidence of endophthalmitis after cataract surgery in the setting of uveitis and immunosuppressive therapy within the IRIS® registry, 00347-1 *Ophthalmology*. 2025;S0161-6420(25). https://doi.org/10.1016/j.ophtha.2025.06.005.
18. Chen SP, Baveja GB, Chang DF. Quantifying the reduction in economic and environmental waste from multi-use phacoemulsification tubing/cassettes and

diamond blades. *J Cataract Refract Surg.* 2025. https://doi.org/10.1097/j.jcrs.0000000000001784. Epub ahead of print. PMID: 40922077.
19. Shukla AG, Chang DF, Dhanaseelan T, et al. Reusing surgical materials for cataract surgery: an assessment of potential contamination. *J Cataract Refract Surg.* 2024;50:993–999. https://doi.org/10.1097/j.jcrs.0000000000001509.
20. Haripriya A, Ravindran RD, Robin AL, Shukla AG, Chang DF. Changing operating room practices: the effect on postoperative endophthalmitis rates following cataract surgery. *Br J Ophthalmol.* 2023;107:780–785. https://doi.org/10.1136/bjophthalmol-2021-320506.
21. Yang-Seeger D, Neo YN, Findl O, et al. Perioperative practice patterns for cataract surgery - a Cross-Sectional european study. *J Cataract Refract Surg.* 2025. https://doi.org/10.1097/j.jcrs.0000000000001669.
22. Chang DF, Mamalis N. Ophthalmic instrument cleaning and sterilization task force. Guidelines for the cleaning and sterilization of intraocular surgical instruments. *J Cataract Refract Surg.* 2018;44:765–773. https://doi.org/10.1016/j.jcrs.2018.05.001.