

# The Economic and Environmental Burden of Hydrophilic and Hydrophobic IOLs in the UK.

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## Background and Objectives

- Posterior capsular opacifications (PCOs) can occur after cataract surgery and is treated by an Nd:YAG capsulotomy procedure.
- The material of an intraocular lens (IOL) implanted during cataract surgery affects the rate at which a PCO may occur, thereby affecting the rate at which an Nd:YAG capsulotomy procedures need to be performed.
- The Nd:YAG capsulotomy procedure has its own rate of adverse events (AEs) that may occur after procedure completion.
- Therefore, the downstream healthcare burden after cataract surgery is directly influenced by the type of IOL used during cataract surgery.

## Methods

- The National Ophthalmology Database (NOD) data was used to calculate and compare the burden associated with different IOLs implanted during cataract surgery.
- There was a total of 375,605 cataract surgeries recorded in the NOD 2022 census: 177,843 hydrophobic and 197,762 hydrophilic IOLs.<sup>1</sup>
- The cost of Nd:YAG capsulotomies was calculated by multiplying the number of cataract procedures in the NOD 2022 census with the Nd:YAG capsulotomy rate and cost in **Table 1**.
- The costs of Nd:YAG capsulotomy AEs were calculated by the product of the Nd:YAG capsulotomy rate calculation multiplied by the AE cost of interest in **Table 1**.
- The time required for each Nd:YAG capsulotomy (**20 minutes**) was multiplied by the Nd:YAG capsulotomy rate to identify the time burden created by different IOL materials.
- Carbon emissions per Nd:YAG capsulotomy procedure was calculated previously (**11.14 kgCO<sub>2</sub>e/procedure**) and multiplied by Nd:YAG capsulotomy rate for each IOL material.<sup>2</sup>

Table 1: Nd:YAG Capsulotomy Burden Parameters

	Rate	Cost
Hydrophobic IOL 3-Year Nd:YAG Capsulotomy	4.2%	£173
Hydrophilic IOL 3-Year Nd:YAG Capsulotomy	14.9%	£173
Ocular Hypertension/Glaucoma	9.6%	£106
Macular Edema	6.4%	£313.30
Retinal Detachment	0.5%	£1,759

Table 1 depicts the parameters used to calculate the burden associated with Nd:YAG capsulotomies. Capsulotomy rates retrieved from NOD 2022 PCO Report.<sup>3</sup> AE rates from Bezin et al.<sup>4</sup> Procedure costs from NHS 2022/23.<sup>5,6</sup>

Table 4: Carbon Emissions by IOL Material (kgCO<sub>2</sub>e)

	Hydrophobic	Hydrophilic	Difference
Number of Cataract Procedures	177,843	197,762	19,919
Number of Nd:YAG Procedures	7,469	29,467	21,997
Carbon Emissions (kgCO <sub>2</sub> e)	83,209	328,257	245,048
Carbon Emissions (kgCO <sub>2</sub> e) per cataract procedure	0.468	1.660	1.192

Table 5 shows the amount of carbon emissions created due to the large discrepancy in 3-year Nd:YAG capsulotomy rate. The 3-year capsulotomy rate for hydrophilic IOLs is 14.9% while hydrophobic IOLs is 4.2%.<sup>1,2,3</sup>

## Results

### Cost Burden

- Hydrophilic IOLs used in cataract surgery has costed the UK centres from the NOD about **£4,000,000** more than hydrophobic IOLs when adding the cost of Nd:YAG capsulotomies and associated AEs.
- **AcrySof IQ SN60WF** has the lowest total cost per cataract surgery (**£5.94/surgery**) while **Aaren Scientific EC1** has the highest cost per cataract surgery (**£82.90/surgery**).

Table 2: Post-Cataract and Nd:YAG Adverse Event Costs (£)

	Hydrophobic	Hydrophilic	Difference
Nd:YAG Capsulotomy	£ 1,292,207	£ 5,097,711	£ 3,805,504
Ocular Hypertension/Glaucoma	£ 76,009	£ 299,851	£ 223,843
Macular Edema	£ 149,771	£ 590,839	£ 441,069
Retinal Detachment	£ 65,693	£ 259,158	£ 193,465
<b>Total</b>	<b>£ 1,357,901</b>	<b>£ 5,356,869</b>	<b>£ 3,998,969</b>

Table 3 depicts the cost (£) associated with Nd:YAG capsulotomies post-cataract surgery based on the type of IOL implanted. Ocular Hypertension/Glaucoma, Macular Edema, and Retinal Detachment costs are based on the rate of each adverse event occurring after Nd:YAG capsulotomy.<sup>5,6</sup>

Figure 1: Average Cost of Nd:YAG and AEs Post-Cataract Surgery by IOL Type

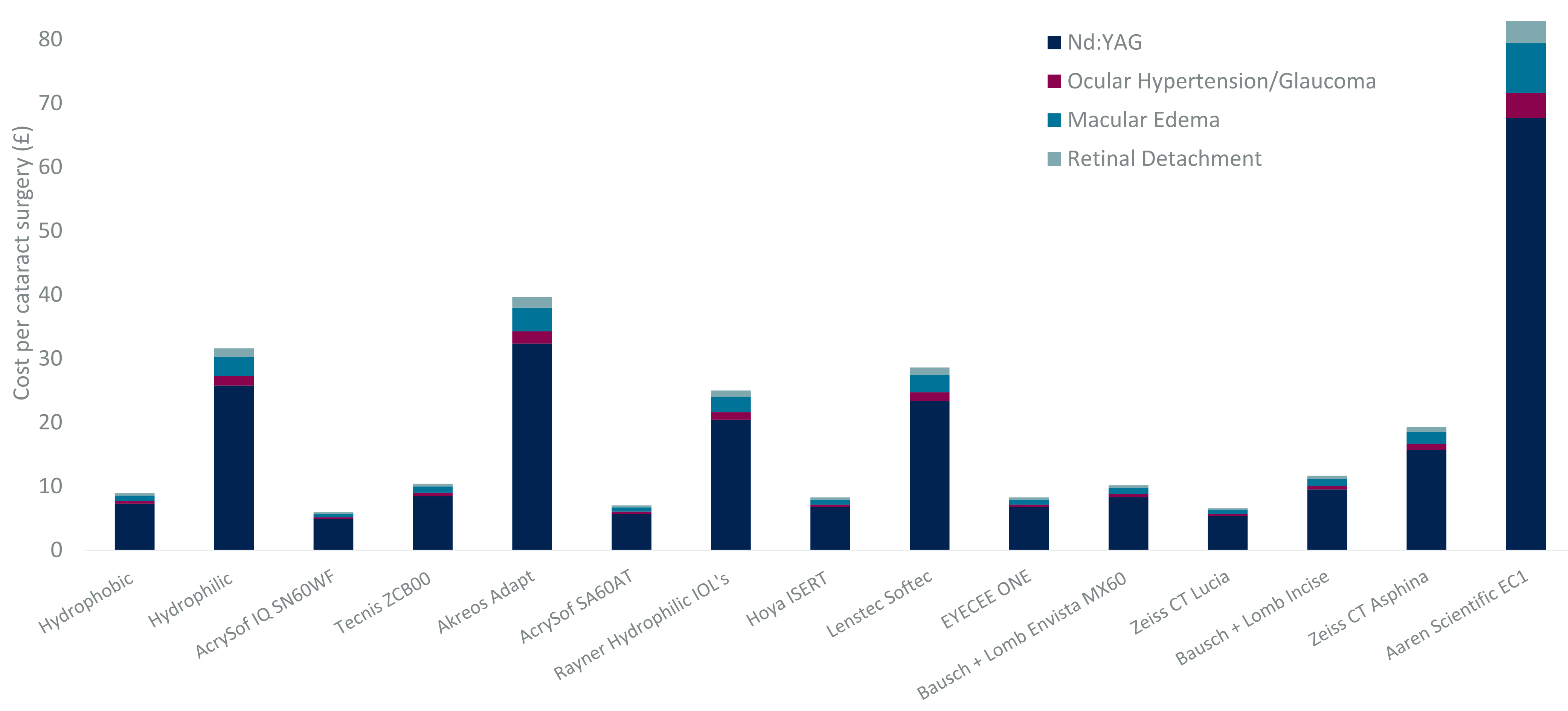


Figure 1 depicts the cumulative cost (£) of adverse events post-cataract surgery. The rates of ocular Hypertension/Glaucoma (red), Macular edema (blue), and retinal detachment (turquoise) are based off the occurrence after Nd:YAG capsulotomy (navy). 3-year Nd:YAG capsulotomy rates retrieved from NOD PCO report 2022.<sup>3</sup>

### Time Burden

- An ophthalmologist who dedicates 1-hour to treat PCOs would spend **47 minutes** treating **hydrophilic IOLs** and only **13 minutes** treating **hydrophobic IOLs (Figure 2)**.
- Hydrophilic IOLs cause an **additional 3,629** Nd:YAG-related AEs when compared to hydrophobic IOLs.

Figure 2: Time Dedicated to Nd:YAG Capsulotomies

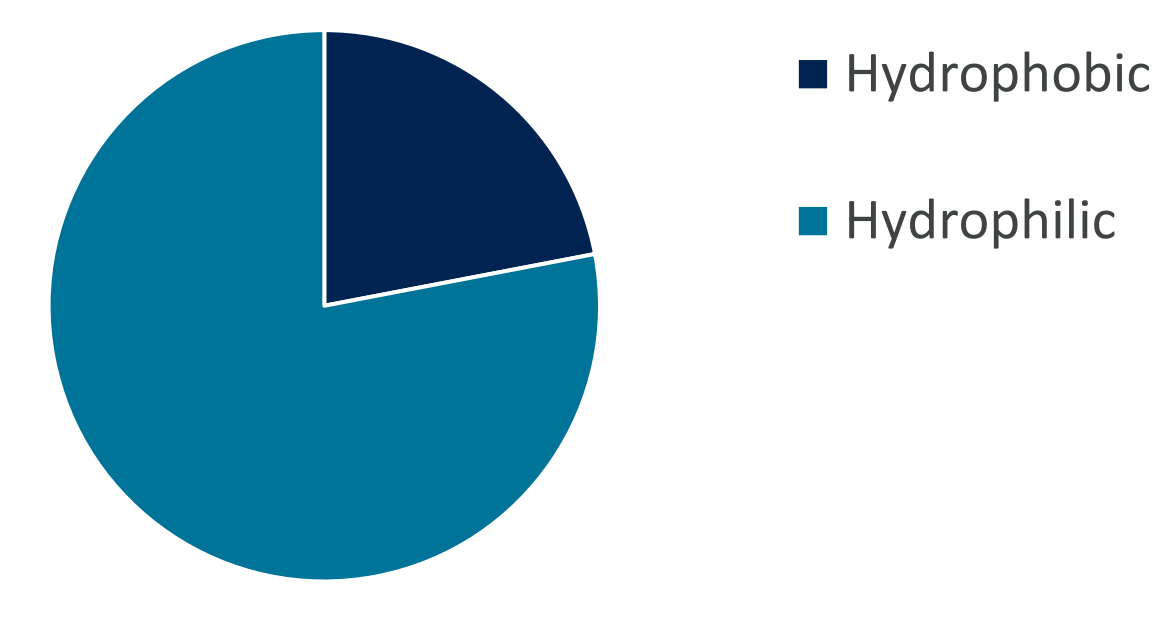


Figure 2 shows that an ophthalmologist would spend 78% of their time treating hydrophilic IOLs (light blue) and only 22% of their time treating hydrophobic IOLs (navy).

Table 3: Total Nd:YAG AEs by IOL Material

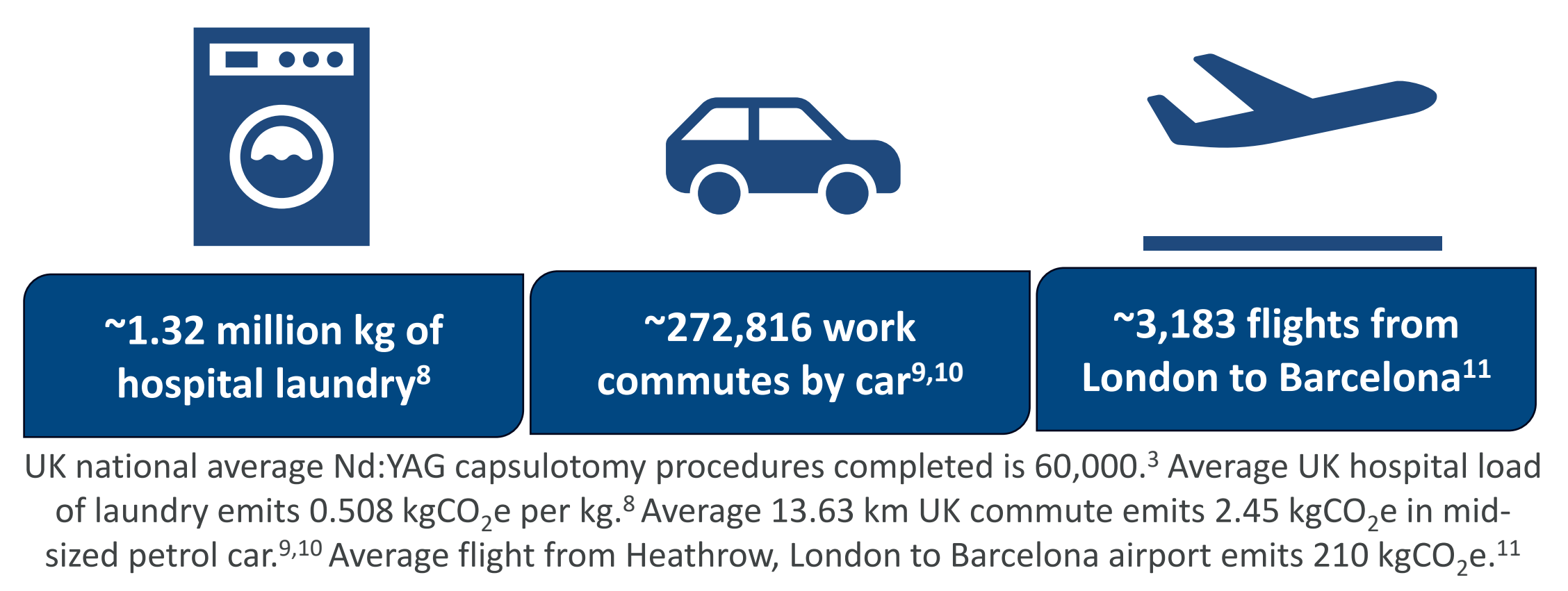
	Hydrophobic	Hydrophilic	Difference
Ocular Hypertension/Glaucoma	717	2,829	2,112
Macular Edema	478	1,886	1,408
Retinal Detachment	37	147	110
<b>Total Nd:YAG AE Burden</b>	<b>1,232</b>	<b>4,862</b>	<b>3,629</b>

Table 4 depicts the number of adverse events that occur after Nd:YAG capsulotomy by IOL type.

### Carbon Emissions Burden

- NOD 2022 data showed that hydrophilic IOLs were used in 19,919 more cataract procedures than hydrophobic IOLs despite producing **246,048 kgCO<sub>2</sub>e** more carbon emissions than hydrophobic IOLs (**Table 4**). Hydrophilic IOLs produce about **3.5x** more carbon emissions per cataract procedure than hydrophobic IOLs.
- Nd:YAG capsulotomies create a **substantial annual environmental burden** in the UK that can be reduced by using hydrophobic IOLs.

Figure 3: Nd:YAG Carbon Emissions National Burden Estimate



UK national average Nd:YAG capsulotomy procedures completed is 60,000.<sup>3</sup> Average UK hospital load of laundry emits 0.508 kgCO<sub>2</sub>e per kg.<sup>8</sup> Average 13.63 km UK commute emits 2.45 kgCO<sub>2</sub>e in mid-sized petrol car.<sup>9,10</sup> Average flight from Heathrow, London to Barcelona airport emits 210 kgCO<sub>2</sub>e.<sup>11</sup>

## Discussion

These findings highlight the significant advantages of hydrophobic IOLs over their hydrophilic counterparts. Hydrophobic IOLs have a lower Nd:YAG capsulotomy rate which contribute to reduced healthcare costs, increased healthcare efficiency, and reduced carbon emissions. Hydrophobic IOLs therefore promote a better approach to post-cataract surgery care by improving patient outcomes and environmental sustainability.

**Abbreviations** AE = Adverse Event; PCO = Posterior Capsular Opacification; Nd:YAG = neodymium-doped yttrium aluminum garnet; IOL = Intraocular Lens; NOD = National Ophthalmology Database; UK = United Kingdom

**References**

1. Paul Henry John Donachie BB, Martina Olaitan, John C Buchan (2024) Seventh Annual Report of the National Cataract Audit. *National Ophthalmology Database Audit 7<sup>th</sup>*
2. Sunil Mamtora VN, Daniel Loveless, Joshua Rychlik, George Wright, Derek O'Boyle (2024) A Carbon Footprint Analysis of Nd:YAG Capsulotomy Procedures for Posterior Capsular Opacifications in a UK Hospital. (#FP19.10) *European Society of Cataract and Refractive Surgeons (ESCRS). Fira de Barcelona, Spain. 10/09/2024.*
3. Paul Henry John Donachie JMS, John C Buchan (2021) National Ophthalmology Database Audit (HTA).
4. Brezin AP, Labbe A, Schweitzer C, Lignereux F, Rozot P et al. (2023) Incidence of Nd:YAG laser capsulotomy following cataract surgery: a population-based nation-wide study - FreYAG1 study. *BMC Ophthalmol* 23 (1): 417.
5. NHS (2022). 2022/23 National Tariff Payment System: Annex A - National tariff workbook. Available online at: [https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.england.nhs.uk%2Fwp-content%2Fuploads%2F2020%2F1%2F22-23NT\\_Annex-A-National-tariff-workbook\\_Apr22.xlsx&sig=AOvVaw00-sRr\\_QBvzBoUmparr93i&ust=1717860892279008&source=images&cd=ife&opi=89978449&ved=0CAcQppaMhKKEwiAoszT6MmGAvUAAAHQAAAAQBA](https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.england.nhs.uk%2Fwp-content%2Fuploads%2F2020%2F1%2F22-23NT_Annex-A-National-tariff-workbook_Apr22.xlsx&sig=AOvVaw00-sRr_QBvzBoUmparr93i&ust=1717860892279008&source=images&cd=ife&opi=89978449&ved=0CAcQppaMhKKEwiAoszT6MmGAvUAAAHQAAAAQBA). Accessed: September 18 2024.
6. Keith Cooper JS, Geoff Frampton, Petra Harris, Andrew Lavery (2015) The cost-effectiveness of second-eye cataract surgery in the UK. *Age and Ageing* 44 (6): 1026-1031.
7. Joseph John MC, Kieran O'Flynn, Tim Briggs, William Gray, John McGrath (2023) Carbon footprint of hospital laundry: a life-cycle assessment. *BMJ Open* 14 (080838).
8. Gov.UK (2022). National Travel Survey 2022: Household car availability and trends in car trips. Available online at: <https://www.gov.uk/government/statistics/national-travel-survey-2022/national-travel-survey-2022-household-car-availability-and-trends-in-car-trips>. Accessed: July 05, 2024.
9. Gov.UK (2020). Greenhouse gas reporting: conversion factors 2019. Available online at: <https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2019>. Accessed: July 03 2024.
10. Carbon Footprint (Web Page) Flight carbon footprint calculator. Updated Available online at: <https://calculator.carbonfootprint.com/calculator.aspx?tab=3>. Accessed: July 03 2024.

