

Reducing Anaesthesia's Carbon Footprint: A Survey of Awareness and Attitudes

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Abstract

Aims

This study aimed to explore Irish anaesthesiologists' attitudes toward environmentally sustainable anaesthesia, including perceptions of safety, efficacy, and policy influences on anaesthetic choice.

Methods

A cross-sectional online survey was distributed to anaesthesiologists across Ireland between March and June 2025. The questionnaire assessed demographic factors, preferences for intravenous versus inhalational anaesthesia, environmental awareness, and institutional support. Descriptive and comparative statistical analyses were performed.

Results

A total of 98 responses were received. Patient factors and ease of administration were the primary determinants of anaesthetic choice, while cost was less influential. Environmental considerations were common, with 71 (72%) reporting they consider environmental impact when selecting an anaesthetic technique. Most respondents (n=86, 88%) were willing to modify their practice to reduce environmental harm, yet 55 (56%) felt their institution did not provide adequate environmental education or guidance.

Discussion

Irish anaesthesiologists demonstrate strong awareness and willingness to engage in sustainable practice, but institutional training and policy support remain limited. Targeted education and system-level initiatives may enhance environmentally responsible anaesthetic care.

Introduction

The climate crisis presents an unprecedented set of challenges for healthcare systems worldwide. Despite its essential role, modern healthcare contributes substantially to the global carbon footprint. Within this sector, anaesthetic practice—particularly the use of volatile anaesthetic gases—remains a notable source of emissions. In 2019 alone, inhaled anaesthetic agents used in Ireland produced an estimated 17,865 tonnes of CO₂e.¹ These figures underscore the tangible environmental burden of routine anaesthetic care and highlight the urgency of adopting evidence-based strategies to reduce emissions. Additionally, the World Federation of Societies of Anaesthesiologists issued a consensus statement encouraging clinicians to minimise the environmental impact of their practice and to use environmentally preferable medications and equipment whenever clinically safe.² However, translating these recommendations into measurable, sustainable practice changes across diverse hospital settings remains challenging.

The primary aim of this study is to understand the perceptions of safety, efficacy, environmental considerations, and the impact of existing policies on the choice of anaesthetic agents. This research seeks to identify the key factors that influence anaesthesiologists' practice preferences. By examining the balance between clinical outcomes and environmental sustainability, the study aims to contribute to the broader discussion on reducing the healthcare sector's carbon footprint and waste production. Through a comprehensive survey of anaesthesiologists in Ireland, the project will provide insights into the potential for policy and practice changes that could support more environmentally friendly and cost-effective anaesthesia procedures.

Methods

This cross-sectional, survey-based study evaluated anaesthesiologists' attitudes toward environmentally sustainable anaesthesia practices in Ireland. A Qualtrics survey was developed based on existing literature and refined through input from clinical anaesthesiologists and academic researchers. It covered demographics, preferences for inhalational versus intravenous anaesthesia, environmental considerations influencing practice, and perceptions of policy or guideline gaps. The instrument underwent internal pretesting for clarity.

Participants included doctors in the Irish Specialist Anaesthesiology Training Programme, non-training scheme doctors (NTSDs) working in anaesthesia, and consultant anaesthesiologists. Using a non-probability sampling method, survey links were distributed via email to anaesthesia departments nationwide, with voluntary, anonymous participation encouraged.

Data were collected online between March and June 2025, with electronic informed consent was required before participation.

Variables included level of training, subspecialty interest, and Likert-scale responses assessing attitudes and practices. Primary outcomes were the influence of environmental concerns on anaesthetic choice and perceived barriers to sustainable practice. Descriptive statistics summarized participant characteristics and survey responses. Not all respondents who initiated the survey completed all questions. As a result, the total number of responses (n) varies between tables and between individual items. Analyses were performed using available-case analysis, whereby all completed responses for each question were included, even if the respondent did not complete the entire survey.

Ethical approval was granted by the University College Cork Social Research Ethics Committee.

Results

The survey was distributed via 68 emails sent to anaesthesiologists identified through publicly available hospital contact information. Recipients were asked to circulate the survey among their colleagues within their respective institutions. Responses were received from Cork University Hospital, South Infirmary Victoria University Hospital, Mercy University Hospital, University Hospital Kerry, Mater Private Cork, St. James's Hospital, Tallaght University Hospital, the Rotunda Hospital, Cappagh National Orthopaedic Hospital, Mayo University Hospital, Our Lady of Lourdes Hospital (Drogheda), University Hospital Limerick, Tipperary University Hospital (Clonmel), Waterford University Hospital, and Letterkenny University Hospital. No reminder emails were sent, and the total number of anaesthesiologists at each institution was not available; therefore, a response rate could not be calculated.

Of the 98 respondents, 19% (n=19) were Senior House Officers (SHOs), 10% (n=10) were Registrars, 18% (n=18) were Specialist Registrars, 1% (n=1) were Fellows, and 51% (n=50) were Consultants. Regarding subspecialty distribution, 61% (n=60) primarily worked in adult anesthesia, 2% (n=2) in pediatrics, 3% (n=3) in regional anesthesia, 1% (n=1) in pain medicine, and 4% (n=4) in obstetrics. A notable proportion, 29% (n=28), reported that they move between areas or are not subspecialized.

Preferences and Decision-Making Factors in Selecting Anaesthetic Method

Participants were asked about their preferences for anaesthetic techniques and the factors that influence their decision-making (Table 1).

Field	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I prefer using inhalation anaesthetics over intravenous anaesthetics.	10	20	24	24	13
I prefer using intravenous anaesthetics over inhalation anaesthetics for most cases.	10	24	18	21	17
My choice of anaesthetic method depends primarily on patient factors.	4	5	12	33	36
The ease of administration of my preferred anaesthetic method is an important factor in my choice.	5	11	16	34	25
Cost effectiveness of my preferred anaesthetic method is an important factor in my choice.	12	28	23	27	1

Table 1: Likert scale responses to preferences and attitudes of anaesthesiologists (n=91).

Preferences for inhalational versus intravenous anaesthesia were mixed. For inhalational agents, 41% (n=37) agreed, 33% (n=30) disagreed, and 26% (n=24) were neutral. A similar pattern was seen for intravenous preference: 42% (n=38) agreed, 38% (n=34) disagreed, and 20% (n=18) were neutral.

Most respondents indicated their anaesthetic choice was driven by patient factors, with 77% (n=69) agreeing. Only 10% (n=9) disagreed, and 13% (n=12) were neutral. Ease of administration was also commonly endorsed: 64% (n=59) agreed, 18% (n=16) disagreed, and 18% (n=16) were neutral.

Cost effectiveness was the least influential factor. Only 31% (n=28) agreed, while 44% (n=40) disagreed, and 25% (n=23) were neutral.

Environmental Awareness in Anaesthetic Practice

Participants were asked to indicate their level of agreement with five statements related to their awareness, understanding, and willingness to act on the environmental impacts of anaesthetic practice (Table 2).

Field	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I consider the environmental impact when choosing an anaesthesia method.	5	9	15	42	17
I believe that intravenous anaesthetics have a lower carbon footprint than inhalation anaesthetics.	3	8	14	31	32
I understand the carbon footprint associated with inhalation anaesthetics.	2	3	8	42	33
I have a clear understanding of the differences in carbon footprint between different inhalation anesthetic agents (e.g., sevoflurane, desflurane).	4	10	6	26	42
I am willing to modify my anaesthetic practices to reduce environmental harm.	2	3	8	36	39

Table 2: Likert scale responses to anaesthesiologists reported practices (n=88).

Most respondents considered environmental impact when selecting an anaesthetic technique, with 67% (n=59) agreeing to some extent and 16% (n=14) disagreeing; 17% (n=15) were neutral. A majority 72% (n=63) agreed that intravenous anaesthesia carries a lower carbon footprint than inhalational agents, while only 12% (n=11) disagreed and 16% (n=14) were neutral.

Self-reported knowledge of environmental impact was generally high: 85% (n=75) reported understanding the carbon footprint of inhalation anaesthetics, with only 5% (n=5) disagreeing and 10% (n=8) remaining neutral. Similarly, 77% (n=68) agreed they understood differences between specific inhalational agents (e.g., sevoflurane vs desflurane), with 16% (n=14) disagreeing and 7% (n=6) neutral. Most participants (85%, n=75) were willing to modify their practice to reduce environmental harm, with 6% (n=5) disagreeing and 9% (n=8) remaining neutral.

Attitudes Toward Environmental Education, Policy, and Advocacy in Anaesthesia

Respondents were asked to rate their level of agreement with five statements related to environmental sustainability in anaesthetic practice (Table 3).

Field	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
My institution provides education or training on the environmental impact of anaesthetic practice.	25	20	9	25	9
Institutional policies significantly influence my choice of anaesthetic methods.	17	16	15	27	12
The transition to more environmentally friendly anaesthetic methods would require significant changes to workflow.	6	24	17	33	8
Anaesthesiologists play an active role in advocating for environmentally sustainable practices in healthcare.	4	6	15	39	24
I am willing to advocate for more environmentally friendly anaesthesia practices in my institution.	4	3	9	48	24

Table 3: Likert scale responses to barriers and enablers of environmentally sustainable anaesthesia practices (n=88).

Most respondents felt their institution does not provide training on the environmental impact of anaesthetic practice, with over half (51%, n=45) disagreeing and only about 39% (n=34) agreeing, and 10% (n=9) remaining neutral. Perceptions of institutional policies were more mixed: although roughly 38% (n=33) disagreed that policies influence anaesthetic choice, nearly half agreed (45%, n=39), and 17% (n=15) were neutral.

Many respondents believed that using more environmentally friendly anaesthetic methods would require notable workflow changes, with 47% (n=41) agreeing, 34% (n=30) disagreeing, and 19% (n=17) being neutral. Most participants felt that anaesthesiologists play an active role in promoting sustainable practices, with 72% (n=63) agreeing, 11% (n=10) disagreeing, 17% (n=15) as neutral. A similarly strong majority expressed personal willingness to advocate for environmentally friendly anaesthesia within their institution, with 82% (n=72) agreeing, 8% (n=7) disagreeing, 10% (n=9) remaining neutral.

Discussion

Most Irish anaesthesiologists have a good understanding of the environmental impact of anaesthetic practice. This contrasts with findings from international surveys indicating that most clinicians remain unaware of the global-warming impact of their anesthetic practices and that environmental concerns have little influence on their choice of anesthetic technique.³ However, these findings should be interpreted with caution, as there may be a selection bias in questionnaire responses; anaesthesiologists who are already interested in or motivated by environmentally sustainable anesthesia practices may have been more likely to participate in the survey.

Interestingly, providers were divided in their preference for intravenous versus inhalational anesthesia. Most respondents indicated that their anesthetic choice was driven primarily by patient factors and ease of administration. This is expected, as factors such as the type of procedure, patient comorbidities, and operating theatre availability commonly influence anesthetic decision-making.

Most respondents did not consider cost-effectiveness when selecting an anesthetic technique. Clinicians may perceive that clinical safety, patient-specific factors, and outcomes—such as hemodynamic stability, speed of recovery, and side-effect profiles—carry greater importance than cost in individual decision-making. Furthermore, calculating the true cost of inhalational versus intravenous anesthesia can be challenging due to wide variation in contributing factors, including anesthetic drug prices, antiemetic use, required syringes and tubing, and differences in PACU resource utilization.

Participants generally reported good subjective understanding of the carbon footprint associated with inhalational agents, including differences between specific gases such as sevoflurane and desflurane. This aligns with the finding that many respondents considered environmental impact when choosing an anesthetic method. A majority agreed that intravenous anesthesia carries a lower carbon footprint than inhalational techniques. This is supported by recent evidence showing that TIVA produces approximately 20 times lower carbon dioxide-equivalent emissions per procedure (2.42 kg vs. 48.85 kg).⁴ However, TIVA is not without drawbacks—most notably the increased use of disposable medical supplies, with estimates suggesting approximately 72 g of plastic waste generated per TIVA case.⁵

The most significant barrier to implementing environmentally sustainable anesthesia practices appears to be systemic. Most respondents disagreed that their institution provides adequate education or training on the environmental impact of anesthetic practice. Opinions were more evenly divided regarding whether institutional policies influence anesthetic choice, which aligns with provider reports that clinical decision-making is primarily driven by patient factors.

Although the College of Anaesthesiologists of Ireland includes environmentally sustainable anesthesia within the Eight Domains of Professional Practice for the National Specialist Training Program, there are currently no core competency requirements to ensure trainees demonstrate proficiency in this area.⁶ The Irish Doctors for the Environment (IDE) Anaesthetic Working Group aims to address this gap by building a network of environmentally engaged anesthesiologists and promoting strategies such as low-flow anesthesia, TIVA, and reduced use of nitrous oxide and desflurane.

Encouragingly, most respondents reported a personal willingness to advocate for greener anesthesia practices within their institution and expressed readiness to modify their individual practice to reduce environmental harm. However, many also felt that doing so would require major workflow changes. With clear institutional support and national guidance, individual clinicians may be better positioned to adopt environmentally sustainable practices more consistently.

Declarations of Conflicts of Interest:

None declared.

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References:

1. Keady T, Nordrum OL, Duffy O, Cummins T, Wall V, Ó'Cróinín D, Lyons B. Annual greenhouse gas emissions from inhaled anaesthetic agents in the Republic of Ireland. *British Journal of Anaesthesia*. 2023 Jan 1;130(1):e13-6.
2. White SM, Shelton CL, Gelb AW, Lawson C, McGain F, Muret J, Sherman JD; representing the World Federation of Societies of Anaesthesiologists Global Working Group on Environmental Sustainability in Anaesthesia. Principles of environmentally-sustainable anaesthesia: a global consensus statement from the World Federation of Societies of Anaesthesiologists. *Anaesthesia*. 2022 Feb;77(2):201-212. doi: 10.1111/anae.15598. Epub 2021 Nov 1. PMID: 34724710; PMCID: PMC9298028.

3. Gonzalez-Pizarro P, Koch S, Muret J, Trinks A, Brazzi L, Reinoso-Barbero F, Diez Sebastian J, Mrf Struys M. Environmental sustainability in the operating room: A worldwide survey among anaesthesiologists. *Eur J Anaesthesiol Intensive Care*. 2023 Jun 9;2(4):e0025. doi: 10.1097/EA9.0000000000000025. PMID: 39917069; PMCID: PMC11783648.
4. Bernat M, Boyer A, Roche M, Richard C, Bouvet L, Remacle A, Antonini F, Poirier M, Pastene B, Hammad E, Fond G, Bruder N, Leone M, Zieleskiewicz L. Reducing the carbon footprint of general anaesthesia: a comparison of total intravenous anaesthesia vs a mixed anaesthetic strategy in 47,157 adult patients. *Anaesthesia*. 2024;79(3):309-17. doi:10.1111/anae.16221.
5. Bernat M, Cuvillon P, Brioussel T, Roche M, et al. The carbon footprint of general anaesthesia in adult patients: a multicentre observational comparison of intravenous and inhalation anaesthetic strategies in 35 242 procedures. *Br J Anaesth*. 2025;134:1620-7. doi:10.1016/j.bja.2025.00148-5.
6. College of Anaesthesiologists of Ireland. *Curriculum for the National Specialist Anaesthesiology Training Programme*. 2nd ed. Dublin: CAI; 2020 [cited 2025 Nov 17]. Available from: <https://www.anaesthesia.ie/wp-content/uploads/2020/07/CAI-Curriculum-2020.pdf>