



INFORMATION ON THE ENVIRONMENTAL IMPACTS OF DESFLURANE USE

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The Potential Harm Caused by Desflurane

Inhaled anesthetic agents undergo minimal metabolism and mostly remain chemically intact upon release into the environment.^{1,2} The environmental damage caused by Desflurane has been stated as significant and the most harmful of all inhaled anesthetics. It has a quoted Global Warming Potential (GWP) of 2540 (CO₂ has a GWP of 1)³ and it has an atmospheric lifetime (AL) longer than the other volatile anesthetic agents (please refer to the table below).^{3,4}

MAC inhaled agent	Atmospheric lifetime (years)	100-year Global Warming Potential (GWP) ⁷¹ (per kg, in comparison with 1 kg CO ₂ , where GWP CO ₂ = 1)	Equivalent auto miles* driven MAC-hour of anesthetic use at 1 L/min
Isoflurane 1.2%	3.6	539	8
Sevoflurane 2.2%	1.9	144	4
Desflurane 6.7%	14	2,540	190
60% Nitrous Oxide (0.6 MAC)	114	273	49

It is notable however, that emission metrics such as GWP and AL may have limitations and uncertainties when it comes to volatile anesthetics. Given the complexity of the physical climate system, they may not be the best metrics to base decisions on to avoid certain anesthetic agents. The Intergovernmental Panel on Climate Change (IPCC)⁵ states that "GWP is not well suited to estimate the cumulative effect on climate from sustained short-lived climate forcer emissions" (lifetime less than 20 years - all current volatile agents fall into this category). Therefore, some climate scientists have argued that their climatic impact may not be as simple, or damaging, as we once thought. Despite this, GWP has been taken up as a simple proxy for converting anesthetic gas emissions to carbon dioxide equivalent (CO₂e) emissions, with personal, departmental and national decisions based on this⁶.

Based on the climate science community, it may be preferable to state the atmospheric concentration and radiative forcing of individual greenhouse gases, along with how the climate system responds⁷. Even though global emissions of anesthetic gases have increased substantially, their atmospheric concentrations are still relatively small, (e.g. 0.37 parts per trillion for desflurane⁸), in part because their short lifetimes help preclude any longterm accumulation.

Radiative Forcing by Anesthetic Gases

Radiative forcing is the difference between the incoming radiation energy and the outgoing radiation energy in a given climate system which, for a stable climate, we would expect to be very close to zero.

Volatile anaesthetics also differ in their radiative forcing effect. Even though the contribution of volatile anaesthetics in their radiative forcing is much less compared to GHGs such as CO₂, methane and nitrous oxide, desflurane's radiative forcing is nearly six times that of sevoflurane.

Table 1 Global atmospheric concentrations, lifetimes, effective radiative forcing values for the three main anthropogenic greenhouse gases and the estimated global radiative forcing for the three main anaesthetic gases.

	Atmospheric concentration; parts per trillion	Atmospheric lifetime; years	(Effective) radiative forcing; Wm ⁻²
Carbon dioxide	420,000,000	100+	2.16
Methane	1,920,000	12.4	0.54
Nitrous oxide	336,000	123	0.21
Desflurane	0.37	14.1	0.00017
Sevoflurane	0.16	1.4	0.00003
Isoflurane	0.11	3.5	0.00006

Climate scientists make sense of all this complexity through modelling the climate system using a supercomputer. None of this complexity is accounted for in emission metrics like GWP. What this means is that expressing anesthetic gas emissions as CO₂e using GWP may misrepresent their impact on global temperature. Some climate experts contend that the mitigation of short-lived climate pollutants can make a more useful contribution to climate protection only after stringent carbon dioxide controls are in place⁹. However, it is true that those short-lived climate pollutants contributing substantial radiative forcing offer significant opportunities for abatement.

Clinical Utility and Cost of Desflurane

In addition to desflurane being the most environmentally damaging volatile anesthetic that we use, its clinical utility has been called into question. We can refer to the existing published literature which compares clinical outcomes and other endpoints (such as time to tracheal extubation) between desflurane and other anesthetic agents^{10, 11, 12, 13, 14, 15}. Although extubation times are quicker with desflurane, a meta-analysis of trials comparing postoperative recovery after anesthesia with sevoflurane or desflurane showed its rapid offset time does not translate to shorter PACU stays⁵. Other studies do not show evidence of improvements in patient-centred outcomes with desflurane, only the quicker emergence time^{14, 16}.

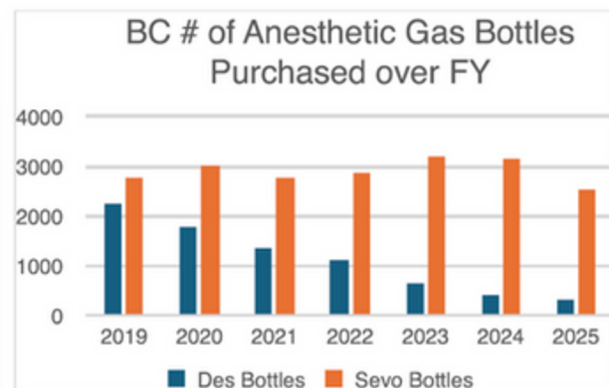
Bottle for bottle, desflurane is more expensive than sevoflurane. In addition to this, desflurane is less potent than sevoflurane evidenced by their minimum alveolar concentration (MAC) values (6% vs approximately 2%). In a publicly funded health system, it may be difficult to justify paying nearly 3 times more for an agent that appears to have no clinical benefit over its alternative.

Fresh Gas Flow Rate (L/min)	Cost of Desflurane (\$)	Desflurane Used (ml)	Cost of Sevoflurane (\$)	Sevoflurane Used (ml)	Potential Cost Savings (\$)
.5L/min	4.42	8.19	1.32	3.14	3.10
1L/min	8.85	16.38	2.64	6.29	6.21
2L/min	17.69	32.76	5.78	12.58	11.91

The calculations were completed based on values described by Moody et al.¹⁷

Given its low potency compared with sevoflurane and the growing use of TIVA, this means that the amount of actual anaesthesia administered using desflurane is minimal. Below is the purchasing data of Desflurane and from 2 health authorities within BC (Interior and Northern Health) over the last five full fiscal years. It demonstrates that the use of desflurane has steadily been declining year on year.

Across BC (2 HAs - IH and NH)		
Fiscal Year	Des Bottles	Sevo Bottles
2019	2239	2749
2020	1775	3015
2021	1341	2776
2022	1092	2841
2023	622	3170
2024	391	3153
2025	331	2535



Campaigns Pressing For Removal and Cessation of Desflurane Utilization

There is a worldwide movement to encourage environmentally sustainable, low-carbon perioperative care, with many organizations and countries (such as Australia, Scotland and the UK NHS) removing desflurane from practice. The Canadian Anesthesiologists Society' in its Guidelines to the Practice of Anesthesia Revised Edition 2025 stated, to reduce the impact of anesthesia care on the environment, that "*desflurane and N2O should be eliminated or minimized to the extent possible given local resources, location, and the clinical context*".¹⁸ ANZCA (the Australian and New Zealand College of Anaesthetists)¹⁹, the ASA (American Society of Anesthesiologists)²⁰ and the Association of Anaesthetists Great Britain and Ireland with the UK Royal College of Anaesthetists²¹ have all put out statements to similar effect.

Heath Quality BC (HQBC) is an organization tasked by the Ministry of Health (MOH) to serve as a focal point for patient safety and quality improvement in British Columbia, as well as promote high-quality and sustainable health care for all. One of HQBC's aims is to decrease the carbon emissions by 10% from clinical practices. One of their strategies to help achieve this is removing Desflurane from the Provincial Formulary²². They are currently collaborating with the MOH, CASCADES Canada and health authorities, to support environmentally sustainable clinical care in British Columbia. CASCADES Canada is an organization that aims to improve the well-being of people, communities and the planet by providing sustainable and innovative solutions that create value.

The national POWER campaign (Planetary Health Organizations for Wellbeing, Equity & Regeneration), is hoping to achieve a Canada-wide phase-out of desflurane by January 2026²³, building on the successes of Newfoundland and Labrador (NFLD) and the Northwest Territories (NWT), who have discontinued Desflurane use in their health systems. This is in alignment of their goal of creating sustainable, climate-resilient healthcare in Canada by the end of 2028.

With this in mind, many health authorities within BC have already voluntarily removed desflurane from their anesthesia practice. **Northern Health, Interior Health, Provincial Health Services Authority and Fraser Health Authority** have already removed desflurane from their operating rooms. In addition to this, **BC Cancer Agency, BC Children's Hospital and BC Women's Hospital** have all removed Desflurane from their formulary too. **Vancouver Coastal Health** will also imminently have Desflurane removed from their formulary.

Arguments Against Removing Desflurane

Some arguments against removing Desflurane may be that we have so little choice in our drugs already, that this will restrict choice even further. Variety assures the possibility of a more suitable choice of anesthetic agent, especially for bariatric and neuroanesthesia. Simply having choice is an important factor. It helps foster autonomy, accountability, and a sense of purpose for physicians. It also fosters self-development: making choices is critical for personal growth, as it allows you to learn, adapt, and actively plan your anesthetic, instead of being a passive recipient of circumstances. One school of thought is that it is important to preserve as many drugs available as possible, to be able to provide tailored use in specific cases.

Desflurane has few but specific indications. It may offer unique benefits in specific situations, such as for patients with ischemic heart conditions where its cardiac depressant properties can reduce myocardial oxygen demand and offer potential protection against ischemic injury.

Backup for Shortages:

A complete ban of one anaesthetic drug might have unknown potential consequences in future crisis situations, such as the shortage of propofol that happened during COVID-19 pandemic. Desflurane can serve as a backup option during shortages of other anesthetic gases like sevoflurane, preventing disruptions to surgical procedures and maintaining patient care.

Lack of a Suitable Alternative:

There are also valid concerns regarding sevoflurane supply chain issues/disruptions. A blanket ban may be difficult without a readily available, safe, and equally effective alternative for all clinical scenarios, especially if it requires specialized equipment or significant changes in anesthesia practice that are not yet widely adopted, e.g. TCI TIVA.

However, a sevoflurane supply chain issue would be unlikely to affect British Columbia in isolation, with many health authorities globally likely to be impacted by such an issue. Sevoflurane is currently marketed by 3 companies in Canada with 9 manufactures in Europe and 6 in the United States. The number of different manufacturers does confer a high level of resiliency to sevoflurane availability.

**VOLATILES WIDELY AVAILABLE:
SEVO AND DES GENERIC NOW**

Sevo became generic in 2006.
Pharma companies manufacturing sevoflurane:

- Abbott Laboratories,
- Baxter,
- Manus
- Aktava
- Biopharma LLP,
- Piramal Pharma
- Lunan
- Waltona Pharma,
- Troika
- Marulshi,
- Abbvie,
- Rowine

Des became generic in 2018.
Pharm companies manufacturing desflurane :

- Rochem International
- Piramal Enterprises
- Jiangsu Hongrui Medicine,
- Baxter Healthcare Corporation
- Blue-Zone Technologies

19. <https://www.coherentmarketinsights.com/blog/insights/key-competitors-sevoflurane-industry-508>
20. <https://www.pharmacompass.com/manufacturers-suppliers-exporters/desflurane>

During a propofol shortage resulting from the COVID pandemic, Health Canada quickly granted authorization to additional European manufacturers to market in Canada. The same process is expected should a future shortage of sevoflurane occur.²⁴ Increased use of Propofol TIVA would have to mitigate Sevoflurane supply chain issues, should they occur.

Conclusion

Environmental stewardship begins with reducing the millions upon millions of small impacts on the planet that are cumulative. Therefore, there is no magic bullet solution, but rather there is likely a need for millions of small solutions working together.

The evidence for the clinical utilization of Desflurane is not particularly strong. There may be anesthesiologists who say that in their hands, desflurane is a better drug, and personal opinions are hard to contend with. However, there are no strong clinical arguments for using it and strong economic arguments for not using it. Climate scientists may say the environmental arguments are weak. Even when using the possibly faulty carbon dioxide equivalent metric, NHS England suggested that volatiles contributed about 1.5-2% of its total carbon footprint [2]. With the NHS being responsible for about 4% of total UK emissions, this would put volatiles annual contribution to the UK carbon footprint at 0.06-0.08%.

Even if desflurane accounts for a tiny proportion of GHG, we should all do our part, where we can. Ultimately, those negating the climate impacts from their personal anesthetic practice are not in the majority, and may be part of the global tragedy of the commons. If we all behave like our personal contribution is insignificant, we all may sink in the same ship. Action is better than inaction, and small actions in the right direction should be encouraged.

There is no suggestion that the anaesthetic work on desflurane has substituted for other work on the environment: in fact, the opposite is true. This was the first big project that many anesthetic departments in Scotland undertook, and it acted as the lodestar that brought them together. The enthusiasm and sense of agency this generated led to many further environmental projects and contributed to the creation of the Scottish Green Theatre group, which is making substantial inroads into tackling the environmental impact of operating theatres. This is where positive climate impacts happen - when people demonstrate leadership and change within their own sphere of influence, which can then lead to further positive changes by other groups.

There is rapidly declining use of Desflurane within the province, with many health authorities voluntarily removing it from their formulary. Provincial and National bodies are heavily invested in removing Desflurane from their respective formularies too. There is a strong possibility that the movement to remove desflurane will ultimately be successful.

Irrespective of our total contribution to climate change, the science supports that desflurane is more harmful to the environment compared with sevoflurane. Desflurane has significantly higher atmospheric concentrations than sevoflurane and isoflurane, contributing 81% of the radiative forcing of the halogenated anaesthetic agents [5]. Taking the economic, clinical and perhaps environmental considerations, all healthcare sectors are already beginning to remove desflurane from clinical practice.

Choosing sevoflurane on the grounds of clinical, economic and environmental reasons aligns with the triple bottom line approach by considering impacts on 'people' (e.g. the patient, staff members, and broader society), 'planet' (i.e. environmental sustainability) and the 'public purse' (i.e. healthcare finances). Desflurane can likely be withdrawn without clinical risk to patients.

There will likely not be a consensus opinion on the desflurane issue, but the fact that it is generating discussion is bringing the environmental aspects of our practice to the forefront, which ultimately, is a good thing.

There are other larger sustainability issues affecting the environment, which we need to address also. With campaigns by HQBC and POWER, this is arguably the most pressing and time sensitive at the moment.

Ultimately, a collaborative approach will assist in developing a comprehensive strategy for a smooth and effective transition. There is no reason why both long and short-lived pollutants cannot be addressed simultaneously. Reducing short-lived climate pollutants (SLCPs), such as desflurane, will yield results sooner rather than later, ameliorating some of the worst effects of the climate change that are 'locked in' by longer-lasting pollutants. A policy brief by the World Health Organization states that, "Globally, comprehensive mitigation measures targeting SLCPs could cut the rate of global warming in half (a 0.6°C reduction) ... by 2030" (WHO 2022). As the compressed timeframe available to achieve the goals of the Paris Agreement (keeping well below 2°C this century) has become more evident, the importance of addressing SLCPs as part of mitigation efforts has become magnified (Ross et al 2018).

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