

Anaesthesia, Climate Change, & the Anaesthetist—the interlink and the need to change our practice

Simple perspective

One hour of anaesthesia with desflurane is equal to driving 450-750 kilometres in a motor car, with sevoflurane 30 kilometres and with isoflurane 30-60 kilometres. So an anaesthetist using desflurane for one hour has contributed to emissions equivalent to driving a car to Bhopal or Gorakhpur while another anaesthetist using sevoflurane has driven only from Noida to Gurgaon¹.

Effect of different volatile anaesthetics on Earth's climate

An atmospheric gas becomes a greenhouse gas (GHG) by absorbing and reflecting infrared radiation that would otherwise escape into space. GHGs contribute to the warming of the Earth's troposphere and surface². It must be appreciated that warming of these two (among other things) leads to changes broadly labelled as climate change. Eg. Melting of Arctic ice, melting of glaciers, intensification of cyclone systems etc

Volatile anaesthetics (VAs) used to induce/ maintain general anaesthesia, including nitrous oxide, are potent GHGs.

The most commonly used metric to measure environmental impact of GHGs is global warming potential GWP. GWP calculates how much heat a GHG/VA traps in the earth's atmosphere over a time period of 100 years compared with a reference gas which is universally taken as carbon dioxide (as per Kyoto Protocol)³.

From table 1, it can be inferred that GWP of desflurane at 20 years and 50 years is much higher compared to sevoflurane and isoflurane. Hence the warming potential of desflurane is greatest among all VAs.

Table 1: GWPs of commonly used volatile anaesthetic agents

	GWP @ 1 year	GWP @ 20 years	GWP @50 years	GWP@100 years
Isoflurane	6600	1795	847	490
Sevoflurane	4284	795	374	216
Desflurane	8526	5513	3047	1778
Nitrous Oxide	210	263	275	264

Since GWP compares 1 kg of species with the others, and thus does not represent that inhalational agents are used in clinically different concentrations, carbon dioxide equivalency (CDE) reflecting clinical use at 0.5 L/min fresh gas flow is a better metric. Table 2 shows CDE for inhalational agents at 1 minimum alveolar concentration (MAC) using isoflurane at

1.2% volume percent, sevoflurane at 2%, desflurane at 6%, and N₂O at 66%. Nitrous oxide was calculated in clinically used concentration instead of at 1 MAC³.

The table shows CDE of N₂O surpasses isoflurane and sevoflurane after 10 years (20 years in the table) and keeps on increasing, 2nd only to desflurane. N₂O has an atmospheric lifetime of 114 years, much higher than other VAs, behaving like a **stock pollutant** thereby elevating its CDE, despite having a lower GWP.

CDE of desflurane is 17 times and 20 times that of sevoflurane at 20 years and 100 years respectively. Hence both desflurane and nitrous oxide are bad for the environment.

Table 2: carbon dioxide equivalent of commonly used volatile anesthetic agents

	CDE @1 year	CDE @ 20 years	CDE @ 50 years	CDE @ 100 years
Isoflurane	18267	4969	2346	1356
Sevoflurane	21429	3979	1872	1082
Desflurane	107452	69490	38407	22419
Nitrous oxide	7625	9576	10011	9615

Expanded perspective

An anaesthetist using low gas flows with 6% desflurane in 50/50 air/O₂ after intravenous induction in theatres without scavenging, uses 60 ml desflurane during a 7-h operating list. As the gases are vented to the atmosphere this is equivalent to ~ 325 kg CO₂. Assuming alternate working days in a week, 45 weeks/year, over a 40-year career, that anaesthetist would be responsible for releasing 1755 tons CO₂e each ton equalling 1000kgs!!⁴

A 240ml bottle of vaporised desflurane contributes 1296kg CDE while that of isoflurane and sevoflurane contributes 521kg and 132kg CDE respectively over a 20 year period⁵.

Desflurane has an outsized effect on GHG emissions due to

1. High MAC percentage
2. High GWP and
3. Low rate of metabolism⁵.

Desflurane will be decommissioned for use by NHS England in early 2024 and by the European Union in 2026⁶.

An Indian viewpoint

Due to the following reasons, emissions of VAs in India are on the higher side and hence their impact on the climate aggravated

1. Most healthcare setups use high FGFs

2. Lack of AGSS
3. Lack of charcoal absorber and VA capturing device
4. Use of N₂O rather than medical air as a carrying gas

As India strives to ensure access to healthcare across all sections of society → number of surgeries will continue to increase at fast rate → VA emissions will rise.

Reducing carbon footprint when using VAs

1. Use desflurane and N₂O only in clinically indicated cases
2. Avoid using both of them together
3. Wherever possible use low FGFs
4. Monitor MAC thereby avoiding using high concentration of VAs
5. Maintain anaesthesia with total intravenous anaesthesia (TIVA) instead of VAs
6. Get case done under regional anaesthesia (RA), with or without sedation

TIVA: a viable alternative

Reports estimate that healthcare system in the USA contributes 7.6-10% and the UK NHS contributes 5.4% of total annual GHGs. VAs form the single largest component of CO₂e from operating theatres—42 to 55%. Using sevoflurane instead of desflurane decreases CO₂e, however use of TIVA or RA drastically cuts down on carbon footprint of OTs. RA has a CO₂e 5–30 times less than for propofol TIVA which in turn has a CO₂e 1.5–40 times less than for inhalational anaesthetic agents on a MAC-equivalent basis, even at minimal fresh gas flow rate^{6,8}. So carbon footprint of

VAs >> propofol TIVA > RA

TIVA is not the only solution to reducing CO₂e resulting from anaesthesia. A number of approaches have to be combined to get an optimal result, however TIVA has the potential to be the MVP “most valuable player” of this team approach.

Most of us do not have access to programmed syringe pumps used to deliver TIVA. Similarly many anaesthetists do not have access to gas monitoring while using VAs. So it is our mindset which is holding us back from altering our practice to benefit the environment; we do not lack the equipment or knowledge to make TIVA and RA the cornerstone of our practice.

Table 3: Carbon footprint calculation propofol TIVA vs inhalational (sevoflurane/ desflurane) including electricity usage

	Global warming potential	Weight per 7h anaesthesia	kg CO ₂ e per 7h anaesthesia
Propofol	21	0.004kg	0.084
Remifentanil	103	0.000004kg	0.000412
Plastic production	3.25	0.443kg	1.44
Glass production	0.895	0.472kg	0.42
TIVA total			3.2
Desflurane	2540		820
Sevoflurane	130		70

WFSA statement

WHO has declared climate change the most significant threat to human health in the 21st century. World federation of Societies of Anaesthesiologists (WFSA), of which India is a founder member, issued a consensus statement in November 2021 urging anaesthetists around the world to reduce the impact of the profession on climate⁸. They proposed that the **triple bottom line of social, financial and environmental accountability** should be applied to a new scheme to ascertain its benefit to the climate. For eg TIVA is said to pass this triple test. Patients given TIVA have clear headed and faster recovery after completion of surgery (social), it costs lesser (financial) and it is more climate friendly i.e. it causes lesser CO₂e (environmental).

Why should we make the change?

Effects of climate change are all around us. Some glaring ones

- Melting of polar ice caps in Antarctica and Arctic regions
- Disappearance of glaciers—"funeral" march held for Okjokull glacier in Iceland and Pizol glacier in Switzerland
- Wildfires in Amazon rainforest, Australia (2020), Greece (2023), Canada (2023)
- Soaring summer temperatures across European cities
- Intense rainfall and floods in several parts of India—Madhya Pradesh, Maharashtra, Himachal Pradesh etc

Climate change is a catastrophe which will affect everyone irrespective of whether they have contributed individually to it. It is shameful that rich nations, despite experiencing extreme weather events, are unwilling to take responsibility for their historical emissions and refuse to finance the structural changes required in poor countries. CO₂e is measured from 1750 onwards; due to earlier industrialization, emission of "first world" countries peaked in mid 1900s. India's emissions are peaking now as our industrial journey started off in 1960s. India has a low per capita CO₂e so they could have waited a few decades before cutting emissions.

Yet they have been bold at policy level to acknowledge that *climate change is inevitable* and due changes need to be made Accordingly we took the initiative with Prime Minister Shri Narendra Modi making key commitments at UN Climate Change Summit 2021

- 50% of energy requirements to be met by renewable sources by 2030
- Reduce one billion tons of CO₂e by 2030
- Expand non fossil fuel capacity to 500GW by 2030
- Net zero emission by 2070

Similarly anaesthetists should be far sighted and look to adapt to a new climate sensitive world. Though the contribution of our speciality to climate change is small, **it is not insignificant**. I would request every member to make themselves more aware on this topic and if convinced, make suitable changes in their anaesthesia practice. Everyone of us can make a difference and we should look to do it for our future generations as well as ourselves. Change is difficult; nevertheless it is the need of the hour. I am sure many anaesthetists have changed their practice with time with advances in drugs and availability of better technology. The challenge now is to keep our focus on the safety of our patients and adopt practices beneficial for the wonderful planet we inhabit.

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