Green anesthesia: How green is our practice?

The World Health Organization has quoted climate change as an important determinant of health. Ironically, the health-care sector is also one of the major contributors toward global carbon footprint, accounting for about 5% of total carbon emission.[1]

Volatile anesthetic agents (VAAs) are halogenated fluorocarbons and potent greenhouse gases (GHGs), as measured by their global warming potential (GWP). GWP is a measure of the amount of heat, a given gas, traps in the atmosphere compared to similar mass of carbon dioxide (CO_2), and it is often expressed in year time horizon. The GWP values over 20 years horizon (GWP_{20}) for desflurane, isoflurane, and sevoflurane are 6810, 1800, and 440 times higher than those for CO_2, respectively.[2] As less than 5% of VAA gets metabolized in the body, major proportion is released into the atmosphere, contributing to greenhouse effect. The carbon footprint with one Minimum Alveolar Concentration (MAC) use of desflurane at a fresh gas flow (FGF) rate of 0.5 and 2 l/min for 1 h is equivalent to traveling for nearly 380 and 750 km by car, respectively.[3] The atmospheric lifetime of nitrous oxide (N_2O) is about 114 years. It penetrates the stratosphere and causes depletion of ozone layer.[4] All these have a significant impact on climate change.

Hence, it is the time that we all should introspect our clinical practice and minimize the impact on global warming and aim to attain net zero carbon footprint. There are several potential strategies available at our disposal to address this alarming problem. These include the use of total intravenous anesthesia (TIVA) and low-flow anesthesia (LFA), limiting the use of agents such as N_2O and VAA having higher GWP values, opting for regional anesthesia wherever applicable, and adopting to newer technology including the use of reusable devices.

By avoiding the need of N_2O and VAA, TIVA certainly has its benefits, but the amount of plastic waste consumed, like syringes, intravenous tubing, and extensions, should also be taken into consideration. Moreover, it is found that about 45% of all the anesthetic drug waste is accounted to unused propofol.[5] Improper disposal of this may lead to contamination of the water bodies. Hence, incineration at 1000°C for 2 s or disposal of unused propofol solution in bags containing activated carbon is recommended for safe disposal.[6] Life cycle analysis (LCA) follows the "cradle to grave" approach, wherein all the steps starting from manufacturing to disposal are taken into account for estimating the carbon footprint of a product. LCA of various anesthetic agents showed that the contribution from TIVA is negligible in comparison to that from VAA. In a study by Sherman *et al.*,[7] the authors analyzed the life cycle GHG emission of inhalational versus intravenous anesthetic agents and found that the magnitude of GHG emission was nearly 4 times higher for desflurane compared to propofol.

Similarly, the use of modern anesthesia workstations with closed circuits and mainstream capnography has permitted us to use LFA with an FGF rate as low as 250 ml (metabolic flow), thereby significantly reducing the consumption of N_2O and VAA and effectively cutting down the amount of carbon emission. Likewise, use of end-tidal concentration control software which automatically adjust FGF to quickly achieve and maintain the target range of MAC has been shown to reduce the emission of GHGs by 40%.[8] Another novel technique which allows for the exhaled VAAs to be captured and reused by creating a circular economy before they are released into the atmosphere has been described. Though novel technologies to destroy inhalational agents, such as "volatile capture technology" and "gas photochemistry," are still in their prototype stage, all these newer modalities should help us in mitigating the environmental hazards of emitted VAA to a great extent in the near future, but may not be cost-effective in developing countries.[9,10] Moreover, countries like Scotland and UK have come up with policies stating that the use of desflurane will be prohibited in their health-care system from the year 2023 and 2026, respectively.[11,12]

Similar to TIVA, use of regional anesthesia techniques (both central and peripheral nerve blocks) to provide surgical anesthesia plays a greater role in achieving the stated goal as they avoid the use of VAA, and hence, they must be considered on a case-to-case basis. For instance, it is estimated that in USA alone, if regional blocks are used as a choice of anesthetic technique for all the hip and knee arthroplasties, it will cut down the usage of desflurane and N_2O by 112 and 9 tons, respectively.[13] Similarly, use of neuraxial techniques over Entonox for labor analgesia can significantly cut down the carbon footprint.

Use of ethylene oxide (EO) for sterilization of medical equipment has been found to have detrimental effects on the environment, including depletion of ozone layer, and it is also found to be carcinogenic in nature. In 2019, the Environmental Protection Agency issued an order to stop sterilizing medical products using EO. To address this issue, the Food and Drug Administration agency has asked for novel solutions to improve the sterilization processes. This includes a call to identify new or alternative sterilization methods and to develop new strategies to reduce the emission of EO. Similar to EO, use of formaldehyde is also found to be potentially carcinogenic, while gas plasma and heat sterilization are found to be safe.

At times, debate between Patient safety and environmental safety arises, with the pendulum swinging in favor of patients for using the disposable devices and toward the environment by employing reusable devices. LCA comparing single-use versus reusable equipment reveals that single-use disposables typically result in severalfold higher petrochemical use and global GHG emissions. To balance out this, the best solution would be to reuse the devices belonging to noncritical and semi-critical categories as per the "Spaulding classification"[14] after appropriate decontamination and dispose of those belonging to critical category after single usage. Moreover, ongoing collaborative research with disciplines like chemical engineering should add newer insights to the emerging knowledge. This includes reduction in electricity consumption, use of renewable energy, extending the product longevity, finding the material suitable for repeated sterilization, and increasing the use of retired products back into the supply chain to minimize unnecessary waste.[15]

Hence, to protect our own environment and reduce the consequences of greenhouse effect on people, the responsibility is now equally bestowed upon both the government and the health-care industry. The state and central governing bodies should come up with green policies such as recommending the use of only those VAAs having the lowest GWP_{20} values. Teaching and research are also the potential means to create a generation of doctors who can inculcate sustainable practices in their day-to-day life, so that the future progeny can breathe clean air. We, as anesthesiologists, should also be conscious about the long-term effects of our own specialty and should lead the way by adopting sustainable and environment-friendly practices.

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Conflicts of interest

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References

1. Pichler PP, Jaccard IS, Weisz U, Weisz H. International comparison of health care carbon footprints. Environ Res Lett 2019;14:064004. doi: 10.1088/1748-9326/ab19e1.
2. Alexander R, Poznikoff A, Malherbe S. Greenhouse gases: The choice of volatile anesthetic does matter. Can J Anaesth 2018;65:221-2.
3. Varughese S, Ahmed R. Environmental and occupational considerations of anesthesia: A narrative review and update. Anesth Analg 2021;133:826-35.
4. Ryan SM, Nielsen CJ. Global warming potential of inhaled anesthetics: Application to clinical use. Anesth Analg 2010;111:92-8.
5. Mankes RF. Propofol wastage in anesthesia. Anesth Analg 2012;114:1091-92.
6. Schneider D, Ponto J, Martin E. Propofol disposal in the anesthesia setting: Overcoming barriers. AANA J 2017;85:417-23.
7. Sherman J, Le C, Lamers V, Eckelman M. Life cycle greenhouse gas emissions of anesthetic drugs. Anesth Analg 2012;114:1086-90.
8. Tay S, Weinberg L, Peyton P, Story D, Briedis J. Financial and environmental costs of manual versus automated control of end-tidal gas concentrations. Anaesth Intensive Care 2013;41:95-101.
9. Shiralkar S, Field E, Murphy E, Shelton C. The role of volatile capture technology in desflurane disposal from decommissioned vaporisers. Anaesthesia 2023;78:1298-300.
10. Rauchenwald V, Rollins MD, Ryan SM, Voronov A, Feiner JR, Šarka K, *et al*. New method of destroying waste anesthetic gases using gas-phase photochemistry. Anesth Analg 2020;131:288-97.
11. Scottish Government. Making the NHS More Environmentally Friendly. 2023. Available from: https://www.gov.scot/news/making-the-nhs-more-environmentally-friendly. [Last accessed on 2023 Nov 14]
12. NHS England. NHS Standard Contract 2023/24 Service Conditions. 2023. Available from: https://www.england.nhs.uk/wp-content/uploads/2023/03/03-nhssc-fl-scs.pdf. [Last accessed on 2023 Nov 14]
13. Kuvadia M, Cummis CE, Liguori G, Wu CL. 'Green-gional' anesthesia: The non-polluting benefits of regional anesthesia to decrease greenhouse gases and attenuate climate change. Reg Anesth Pain Med 2020;45:744-5.
14. Rowan NJ, Kremer T, McDonnell G. A review of Spaulding's classification system for effective cleaning, disinfection and sterilization of reusable medical devices: Viewed through a modern-day lens that will inform and enable future sustainability. Sci Total Environ 2023;878:162976. doi: 10.1016/j.scitotenv. 2023.162976.
15. MacNeill AJ, Hopf H, Khanuja A, Alizamir S, Bilec M, Eckelman MJ, *et al*. Transforming the medical device industry: Road map to a circular economy. Health Aff (Millwood) 2020;39:2088-97.

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