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Inhaled anaesthesia and analgesia contribute to climate change

We need clear targets and timelines for reducing emissions.

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The healthcare industry is a major contributor to harmful pollution, including nearly 5% of all global greenhouse gas emissions.[1] With their core mission to support health and healing, all health professionals have a duty to prevent environmental pollution. Inhaled anaesthetics are a uniquely clinical source of greenhouse gases, making them of particular interest.[2] Anaesthesiology has generated a large body of work assessing the emissions of these gases and developing mitigation solutions that do not compromise the quality or safety of patients (box 1).[3] However, given their widespread use beyond the operating room, broader engagement is essential, including from professionals in maternity care, paediatrics, cardiology, emergency medicine, and veterinary medicine, as well as colleagues in facility engineering, administration, industry, and government.

Box 1: Strategies for reducing inhaled anaesthetic pollution (adapted from Devlin-Hegedus et al[3])

Clinical practice

- Avoid inhaled anaesthetics and substitute intravenous, regional, or neuraxial anaesthesia when clinically safe to do so[2,4]
- Avoid desflurane and N2O if using inhaled anaesthetics[2,4,5]
- Minimise fresh gas flow rates, including during inductions[6]

Buildings

- Decommission old, and avoid new construction of, N2O central piping systems, and substitute portable tanks that remain closed between uses[7]
- Consider technologies to treat and reuse anaesthetic gases only after all other waste prevention strategies have been optimised[2]

Industry regulations and standards

- Avoid N2O use as a refrigerant in cryosurgery
- Enforce national reporting and mitigation of inhaled anaesthetic greenhouse gas and ozone depleting emissions as set out in the Montreal protocol, including the Kigali amendment on hydrofluorocarbons,[8] and the Paris Agreement[9]

All inhaled anaesthetics are potent greenhouse gases with heat trapping properties (global warming potential) hundreds to thousands of times greater than an equivalent mass of carbon dioxide.[10] In addition, some inhaled anaesthetics, notably nitrous oxide (N2O), also contribute to the depletion of the ozone layer. During clinical use, inhaled anaesthetics are mostly exhaled through gas scavenging (vacuum) systems to protect against indoor occupational exposure and are ultimately all released to the outdoor atmosphere in an uncontrolled manner.

Volatile hydrofluorocarbon anaesthetics (desflurane, sevoflurane, isoflurane), and N2O are used routinely during intraoperative care.[2,11] Although insufficient data are available on the global production and consumption of these medical gases, estimates of their contribution to total global greenhouse gas emissions range from 0.01% to 0.1%.[2,11] In clinical contexts, inhaled anaesthetics can account for 50% of perioperative emissions,[12] 5% of emissions from hospitals,[13,14] and 3% of total national healthcare emissions.[2,11,13,14] Concern is also growing over the extensive use of these inhaled anaesthetics by veterinary services and in the care of laboratory animals, although emissions from these sources are not yet quantified.[15]

N2O is also widely used for analgesia in labour and in dental clinics, paediatric units, emergency departments, and pre-hospital settings. In the UK, one small study suggested that half of N2O use in hospitals stems from maternity care alone.[16] N2O analgesia is often inadequate in labour, with around 40-60% of women changing to epidural analgesia,[17,18] and more selective use of N2O—for its anxiolytic properties, for example—should be explored. Recent independent reports from the UK, Australia, and the US further note that large fractions (77-95%)[3,7] of hospital N2O are lost before clinical use, through leaking central pipeline systems. Beyond anaesthesia and analgesia, compressed N2O gas is also used as a primary refrigerant for cryosurgery in cardiac and endoscopic ablations.[19]

In clinical doses, the carbon dioxide equivalent emissions associated with desflurane and N2O are about 40 times greater than those associated with sevoflurane or isoflurane at similar gas flow rates.[2,4] And, desflurane and N2O account for the overwhelming majority of measured emissions from anaesthetic gases.[12,13,20] By comparison, life cycle greenhouse gas emissions of intravenous propofol, sedatives, and local anaesthetics are several orders of magnitude lower than for inhaled anaesthetics.[4,21] Environmentally preferable drug and clinical care pathways should be selected when clinically safe; however, care must be taken to avoid excessive consumption of all medicines and supplies, or advantages may be diminished.[22]

New technologies for capturing (volatiles) and destroying (N2O) waste anaesthetic gases may be promising,[2,23] but substantial quantities of gas never make it into scavenging systems for potential collection or destruction.[7,24] For example, the pain of labour makes it difficult for many women to exhale properly through the face masks used to self-administer N2O. Inhaled inductions of anaesthesia and deep extubations are also poorly scavenged and often used in children. Furthermore, patients continue to exhale anaesthetics, even after emergence from anaesthesia.

Reuse of captured and reprocessed volatile drugs has yet to receive broad regulatory approval, and sequestration presents new environmental concerns regarding transportation and storage. The financial and environmental costs of the technologies themselves must also be quantified. The efficacy and efficiency of treating waste anaesthetic gases has not yet been comprehensively evaluated in peer reviewed studies. Avoiding use of inhaled anaesthetics and preventing waste (lowering fresh gas flow rates and decommissioning central pipelines) remain higher priorities.[2 23]

To guide improvement and accountability, health systems should measure their emissions of inhaled anaesthetic gases, set reduction targets and timelines, and track progress. The American Society of Anesthesiologists' inhaled anaesthetic 2022 challenge suggests aiming to reduce emissions by 50% this year.[25] Health facilities can use procurement records to estimate their emissions, and these should be adjusted for clinical activity to enable meaningful comparisons between institutions. Clinician performance can be tracked using mean gas flow rates per hour of anaesthetic and intensity of emissions (kgCO2e/hour) where electronic health records exist. A data driven, iterative process of comparative reporting against best practice standards can be effective in inspiring improvement among individual clinicians and healthcare organisations. Accountability can be enhanced through institutional, national, and international policies and through professional societies.

Efforts to decarbonise healthcare risk not going far enough or fast enough if progress relies on the voluntary initiative of individual clinicians, facilities, or health systems. A regulatory framework of standardised, mandatory reporting and accountability is critical to achieve the widespread engagement required to reduce healthcare's substantial greenhouse gas emissions.

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