

## Anaesthetic gases, climate change, and sustainable practice



Modern anaesthetic gases include the hydrofluorocarbons sevoflurane and desflurane, the chlorofluorocarbon isoflurane, and nitrous oxide. Following use, anaesthetic gases are expelled into the atmosphere, where they contribute to anthropogenic climate change.<sup>1-5</sup> Recently, the atmospheric concentrations of anaesthetic gases have been determined, and the most damaging agent, desflurane, is rapidly increasing.<sup>1</sup> The Montreal protocol aims to phase out global chlorofluorocarbon use, with hydrofluorocarbons subsequently targeted through the 2016 Kigali amendment;<sup>6</sup> however, anaesthetic gases are often excluded from such discussions because of their medical necessity. The damage caused by the release of anaesthetic gases has been comprehensively described; nevertheless, the barriers to sustainable practice changes in anaesthesia has not, we believe, been sufficiently addressed.

Anaesthetic gases represent 5% of the carbon footprint for all acute National Health Service (NHS) organisations, or 50% of gas emissions from the heating of acute NHS buildings and water.<sup>7</sup> Likewise, the use of desflurane or sevoflurane from a modern anaesthetic machine for 1 h is the same as 230 or 30 miles travelled in a modern car, respectively.<sup>8</sup> Despite these comparisons, clinicians struggle to visualise this harm in the context of the good that comes from it.

In 2014, the release of hydrofluorocarbon and chlorofluorocarbon anaesthetic gases stood at the equivalent of 3 million tonnes of carbon dioxide, with 80% of emissions from desflurane alone.<sup>1</sup> An equivalent of 6% of global carbon dioxide emissions result from nitrous oxide, and 1% of these are medicinal. Therefore, if the land area of the UK represented global carbon dioxide emissions, desflurane would be a town the size of Bedford and nitrous oxide would be the size of the metropolitan area of Bristol. The interpretation of this scale is subjective, and although we would argue for a marginal gains approach, others might see the contribution of anaesthetic gases, overall, as negligible.

Along with the personal preferences of individual anaesthetists, the practice of anaesthesia is influenced by patient, surgical, and anaesthetic factors. Despite these varied influences, there is currently no consensus with regards to the balance between beneficence and

maleficence for the immediate patient, and populations affected by climate change.

There is considerable practice variation on the use of hydrofluorocarbon and chlorofluorocarbon anaesthetics, even in the UK, and efforts to standardise their use are often met by many barriers. Furthermore, the scope of change would have to extend far beyond the UK, since climate change is a global phenomenon, and global practices vary widely between countries—this change on the international scale would not be without challenges since practices on anaesthesia use around the world are varied and more difficult to address than at a UK-wide level. Additionally, nitrous oxide continues to be a useful method in the fight against acute pain in some circumstances, for which there is currently no alternative. Therefore, agreeing a standardised approach towards the limitation of harm caused by anaesthetic gases presents obvious problems, since the scope must involve everyone, everywhere.

Although most modern systems ventilate used gases to the outside atmosphere to avoid theatre pollution, new scavenging devices allow for the collection, capture, reuse, or destruction of gases. Despite these apparent advantages, their safety, benefit, usability, reliability, and cost-effectiveness are as yet unproven. Similarly, the elemental anaesthetic agent Xenon is too costly, both financially and in terms of its energy intensive distillation from air. Financial costs are therefore a major barrier to sustainable practice changes.

One could argue that a narrow focus on anaesthetic gases ignores other areas in which clinicians can contribute towards the same goals. Ten such broad examples are keeping up-to-date with recent developments; prescribing antibiotics according to local guidelines; reducing variation in practice and getting treatments or procedures right the first time; encouraging the consumption of less alcohol, less meat, and promoting increased exercise; working with an organisation's quality improvement team to accelerate the adoption of lean working practices; avoiding the use of intravenous drugs when possible, since the sterilisation of intravenous drugs increases their carbon footprint above oral alternatives; reducing, reusing, recycling, and disposing of waste correctly; collaborating with others towards the common purchasing of bulky



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or high-volume items to reduce transport emissions; encouraging patients to take responsibility for their own health; and discussing resuscitation decisions with the patient at an early stage, to ensure that resources are not being used to provide treatment that the patient does not want.

We therefore argue that sustainable anaesthesia is no different to everyday practice: the balancing of benefit and risk for all patients. These barriers to change might explain the continued global use of anaesthetic gases, despite the overwhelming evidence of its contribution to climate change,<sup>1-5</sup> and the effect this has on human populations.<sup>9,10</sup> Rather than further physicochemical studies of anaesthetic gases in the atmosphere, these arguments should be engaged with, and lessons learnt from our past must be translated to health care in the developing world.

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- 1 Vollmer M, Rhee T, Rigby M, et al. Modern inhalation anesthetics: potent greenhouse gases in the global atmosphere. *Geophys Res Lett* 2015; **42**: 1606–11.
- 2 Campbell M, Pierce J. Atmospheric science, anaesthesia, and the environment. *BJA Education* 2015; **15**: 173–79.
- 3 Pierce J. The environment, the gas bill, and the route to sustainable anaesthesia. *RCOA Bull* 2013; **82**: 39–41.
- 4 Sherman J, Le C, Lamers V, Eckelman M. Life cycle greenhouse gas emissions of anesthetic drugs. *Anesth Analg* 2012; **114**: 1086–90.
- 5 Ishizawa Y. Special article: general anesthetic gases and the global environment. *Anesth Analg* 2011; **112**: 213–17.
- 6 UN Environment Programme. Frequently asked questions relating to the Kigali Amendment to the Montreal Protocol. 2016. [http://ozone.unep.org/sites/ozone/files/pdfs/FAQs\\_Kigali\\_Amendment\\_v3.pdf](http://ozone.unep.org/sites/ozone/files/pdfs/FAQs_Kigali_Amendment_v3.pdf) (accessed March 27, 2017).
- 7 NHS Sustainable Development Unit. Carbon Hotspots report. 2012. <http://www.sdu.nhs.uk/corporate-requirements/measuring-carbon-footprint/nhs-carbon-footprint.aspx> (accessed March 27, 2017).
- 8 Ryan SM, Nielsen CJ. Global warming potential of inhaled anesthetics: application to clinical use. *Anesth Analg* 2010; **111**: 92–98.
- 9 Springmann M, Mason-D'Croz D, Robinson S, et al. Global and regional health effects of future food production under climate change: a modelling study. *Lancet* 2016; **387**: 1937–46.
- 10 Watts N, Adger WN, Agnolucci P, et al. Health and climate change: policy responses to protect public health. *Lancet* 2015; **386**: 1861–914.