Appendix D

Anaesthetic Gas in Ontario

One example of a significant, but largely overlooked, source of GHG emissions is anaesthetic gas. As these emissions are not covered by the cap, using Greenhouse Gas Reduction Account funds to reduce them would lead to additional net reductions beyond those achieved by cap and trade.[1]

Inhaled anaesthetic gases, commonly used in hospitals, clinics, dental offices and veterinaries, are potent contributors to climate change, with global emissions reaching 3 million tonnes of CO_2e (excluding nitrous oxide (N_2O)).[2] The most potent gas, desflurane, alone has a climate impact over 2,500 times that of carbon dioxide (CO_2) (Table D1). Less than 5% of all inhaled anaesthetic gases are metabolized, with the remainder often vented to the atmosphere.[3] Commercial technologies to capture these gases (other than N_2O) for destruction or reuse have been installed in some Ontario healthcare facilities, but this is not the norm. Nitrous oxide, unlike the other anaesthetic gases, acts as both an anaesthetic and as a carrier gas for other anaesthetic gases.

Anaesthetics are, of course, medically necessary. Fortunately, there are four practical ways to greatly reduce their climate impacts:

1. Prevent the venting of non-N_2O anaesthetic gases through the installation and use of equipment to capture and destroy or reuse the gas (e.g., Blue Zone[5] and Class 1[6] technologies);
2. Replace a high-impact anaesthetic gas (e.g. desflurane) with a lower impact alternative (e.g., sevoflurane), where medically appropriate;
3. Eliminate the use of N_2O as a carrier gas (except when desflurane is considered medically necessary; the N_2O would reduce the overall climate impact of desflurane use);[7] and
4. Substitute liquid anaesthetic, such as propofol, for intravenous use if medically appropriate. In the United States, for example, non-gaseous anaesthetics comprised about 21% of anaesthetic use in 2013.[8]

Table D1. The atmospheric lifetime and global warming potential of the various inhaled anaesthetic gases used in Ontario.[4]

Gas	Atmospheric Lifetime (years)	Global Warming Potential (100-year time horizon)
Desflurane	14	2,540
Isoflurane	3.2	510
Nitrous oxide	121	298
Sevoflurane	1.1	130

Ontario's health care institutions have begun to use anaesthetic gas capture technologies, with unconfirmed estimates that they exist in 25% of operating rooms.[9] However, there is currently no legal requirement or economic incentive to adopt these technologies.

The climate change impacts of anaesthetic gas use are starting to be recognized and addressed by a number of research institutions, including the Royal College of Anaesthetists, and the Departments of Anesthesiology at Yale University and the University of Wisconsin-Madison.[10] Both the Royal College of Anaesthetists and Yale have developed carbon calculators to make it easier for health care facilities to quantify the climate impacts of their gas use.[11] The University of Wisconsin-Madison designed labels to remind anaesthesiologists of the climate impacts of the various types of gases and the relative benefits of using substitutes for desflurane (Figure D1). These labels are to be attached to desflurane and sevoflurane vaporizer equipment.

Photo credit: "Desflurane Vaporizer Label" "Sevoflurane Vaporizer Label", online: Department of Anesthesiology. University of Wisconsin-Madison <https://anesthesia.wisc.edu/green/UWAnesVaporizerLabelsL.pdf>. [Accessed August 14, 2017]

Figure D1. Labels for desflurane (left) and sevoflurane (right) vapourizers designed by the Department of Anesthesiology at the University of Wisconsin-Madison.

Unfortunately, Ontario has not been collecting any data on the amount of anaesthetics used in the province, nor the rate of adoption of gas capture technologies. Perhaps more importantly, it does not provide any economic incentive for health care facilities to embrace these rather practical methods to reduce emissions. The climate change impacts of these gases can be reduced quite easily. For example, due to climate change concerns, the Yale New Haven hospital no longer includes desflurane in its formulary (i.e., list of medicines for procurement) and since 2013 has not purchased any N_2O for use as an anaesthetic gas.[12] Moreover, the cost of anaesthetic gas capture in Ontario is lower than recent prices of carbon allowances.[13]

The climate impacts of all inhaled anaesthetic gases (except N_2O) are excluded from Canada's National GHG Inventory even though they may be of a considerable magnitude. We know that the nitrous oxide used as anaesthesia in the province was responsible for about 80,000 tonnes of CO_2e in 2015.[14] Unfortunately, the GHG impact of other anaesthetic gases are unknown.

Endnotes

1. The *Hospital Energy Efficiency Program* (HEEP), announced by the province on November 27, 2017, covers the collection and recycling of waste anaesthetic gases (WAGs) which are used in approximately 900 operating rooms across Ontario. Full details of the program, including its GHG reduction potential, were not available as the ECO went to press. See: "Ontario Reducing Carbon Footprint, Boosting Care at Hospitals", online: Ontario Ministry of Health and Long-Term Care <https://news.ontario.ca/mohltc/en/2017/11/ontario-reducing-carbon-footprint-boosting-care-at-hospitals.html?utm_source=ondemand&utm_medium=email&utm_campaign=p> [Accessed December 15, 2017]

2. Martin K. Vollmer *et al.* "Modern inhalation anesthetics: potent greenhouse gases in the global atmosphere" (2015) 42(5) Journal of Geophysical Research 1606 at 1606.

3. Ibid, at 1607.

4. Ibid, at 1607.

5. "Deltasorb Anesthetic Collection Service", online: Deltasorb Anesthetic Collection Service <http://www.bluezone.ca/>. [Accessed August 14, 2017]

6. "Class1 Inc.", online: Class1 Inc. <http://class1inc.com/>. [Accessed August 14, 2017]

7. Susan M. Ryan & Claus J. Nielsen "Global Warming Potential of Inhaled Anesthetics: Application to Clinical Use" (2010) 111(1) Anesthesia & Analgesia 92 at 95.

8. This statistic is cited in Sherman *et al.* (2014), based on data from the Anesthesia Quality Institute's (AQI) National Anesthesia Clinical Outcomes Registry (NACOR). See: Jodi D. Sherman *et al.*, "Estimate of Carbon Dioxide Equivalents of Inhaled Anesthetics in the United States" (2014) American Society of Anesthesiologists Abstract.

9. "News, Articles and Information. Blue-Zone Technologies Ltd. News. December 07, 2016. Canadian Patent Awarded for MedTech Research and Development", online: Deltasorb Anesthetic Collection Service <http://www.blue-zone.ca/news>. [Accessed August 14, 2017]

10. "Anaesthetic gases", online: Sustainable Development Unit. NHS UK <http://www.sduhealth.org.uk/areas-of-focus/carbon-hotspots/anaesthetic-gases.aspx>. [Accessed August 14, 2017]

    "Inhaled Anesthesia Climate Initiative: Project Drawdown", online: Department of Anesthesiology. Yale School of Medicine<https://medicine.yale.edu/anesthesiology/research/inhaledanesthesiaclimateinitiative.aspx>. [Accessed August 14, 2017]

    "Sustainable Anesthesiology", online: Department of Anesthesiology. University of Wisconsin – Madison <https://anesthesia.wisc.edu/index.php?title=Green>. [Accessed August 14, 2017]

11. "Anaesthetic gases", online: Sustainable Development Unit. NHS UK <http://www.sduhealth.org.uk/areas-of-focus/carbon-hotspots/anaesthetic-gases.aspx>. [Accessed August 14, 2017]

    "Inhaled Anesthesia Climate Initiative: Project Drawdown", online: Department of Anesthesiology. Yale School of Medicine<https://medicine.yale.edu/anesthesiology/research/inhaledanesthesiaclimateinitiative.aspx>. [Accessed August 14, 2017]

12. Jodi D. Sherman *et al.*, "Estimate of Carbon Dioxide Equivalents of Inhaled Anesthetics in the United States" (2014) American Society of Anesthesiologists Abstract.

13. Estimate supplied to the ECO by a company which supplies anaesthetic gas capture equipment to health care institutions.

14. Environment and Climate Change Canada, *National Inventory Report 1990-2015: Greenhouse Gas Sources and Sinks in Canada*. Part 3 (Ottawa: ECCC, 2017) at 59. Environment and Climate Change Canada, *National Inventory Report 1990-2015: Greenhouse Gas Sources and Sinks in Canada*. Part 1 (Ottawa: ECCC, 2017) at 159.