Reducing your contribution to climate change: your choice of anesthetics matters!

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- *Are we responsible for the gas we pass.*

Background


By far the most terrifying film
you will ever see.
aninconvenienttruth
A GLOBAL WARNING

Anthropogenic Climate Change

- WHO calls **climate change** the greatest threat to global health in the 21st century

Anthropogenic Climate Change

- Intergovernmental Panel on Climate Change:

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  - ***Total radiating force is positive*** and has led to an uptake of energy by the climate system
  - Human influence is clear. This is evident from the increasing GHG, positive radiative forcing, observed warming, and understanding the climate system

Medical Literature

- 2015 Lancet Commission on Health and Climate Change gave nine recommendations, including empowering health professionals to make positive environmental changes
- Doctors Without Borders:
  "Climate change is the greatest global health threat of the 21st century, so it is incumbent that physicians take a stand to protect their patients"
- CMA policy paper:
  "Health care professionals should act within their professional settings to reduce the environmental impact of medical activities and to develop environmentally sustainable professional settings"

CMA = Canadian Medical Association

Medical Literature

- Journals: American Family Medicine, British Medical Journal, Academic Emergency Medicine, Pediatrics and American Academy of Pediatrics

- JAMA :
  "Clinicians have a powerful and unique opportunity to engage the nation by framing the crisis as a health imperative" and to reduce our carbon intensity and energy consumption at home and at work

JAMA = Journal of the American Medical Association

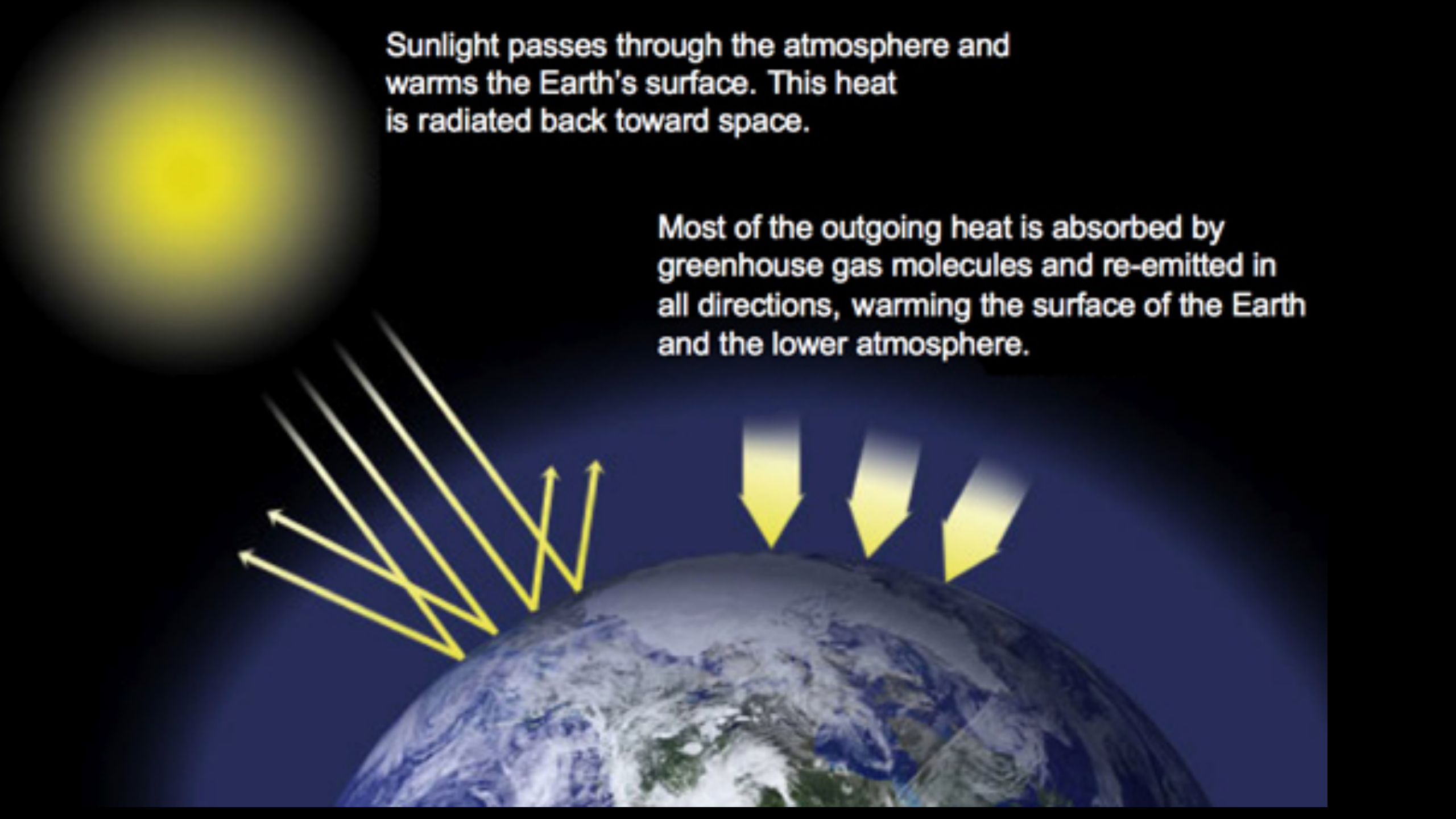
Anesthetics and Global Warming

MEDICAL INTELLIGENCE ARTICLE

Assessing the Impact on Global Climate from General Anesthetic Gases

Mads P. Sulbaek Andersen, PhD,* Ole J. Nielsen, PhD,† Timothy J. Wallington, PhD,‡
Boris Karpichev, PhD,* and Stanley P. Sander, PhD*

Although present in the atmosphere with a combined concentration approximately 100,000 times lower than carbon dioxide (i.e., the principal anthropogenic driver of climate change), halogenated organic compounds are responsible for a warming effect of approximately 10% to 15% of the total anthropogenic radiative forcing of climate, as measured relative to the start of the industrial era (approximately 1750). The family of anesthetic gases includes several halogenated organic compounds that are strong greenhouse gases. In this short report, we provide an overview of the state of knowledge regarding the impact of anesthetic gas release on the environment, with particular focus on its contribution to the radiative forcing of climate change. (Anesth Analg 2012;114:1081–5)


Sunlight passes through the atmosphere and warms the Earth's surface. This heat is radiated back toward space.
Most of the outgoing heat is absorbed by greenhouse gas molecules and re-emitted in all directions, warming the surface of the Earth and the lower atmosphere.

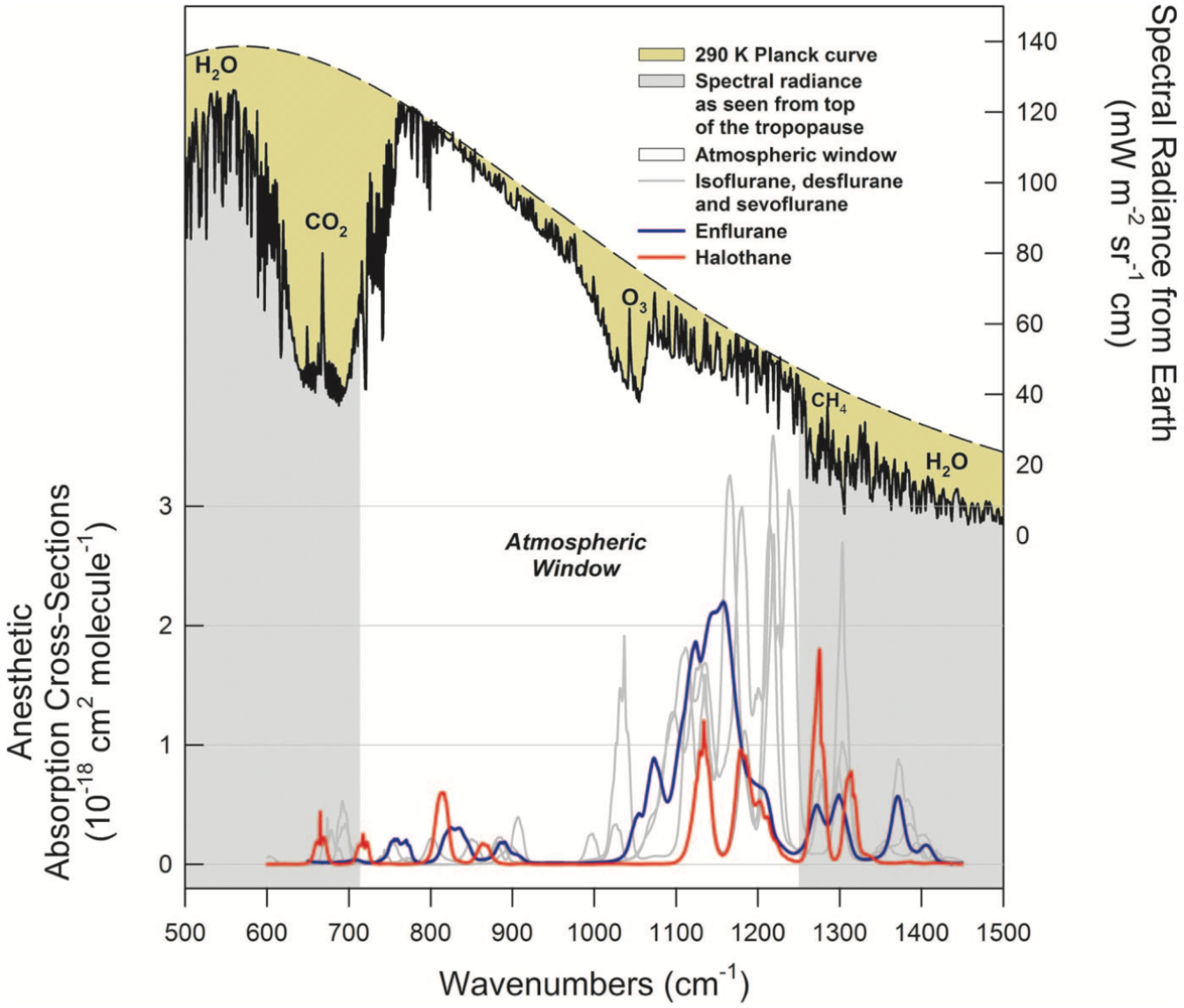


Figure 1. The net upward atmospheric radiance spectrum at the tropopause (personal communication, 2010, R. Beer, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA. Spectral radiance based on Modtran [Spectral Sciences Inc.] atmospheric radiative transfer model calculations), flanked by the ideal Planck function for a blackbody emissions at 290K (black dashed line). The presence of naturally occurring major greenhouse gases in the atmosphere (CO_2, H_2O, O_3, and CH_4) produces attenuation of the outgoing radiation resulting in a nonideal Planck curve. Infrared spectra for halothane (red trace) and enflurane (blue trace), and isoflurane, desflurane, and sevoflurane (gray traces) are shown. These halogenated organic compounds absorb strongly in the atmospheric window region.

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- **Halogenated organic compounds produce 10-15% of the anthropogenic RF of climate.**

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- **Radiative forcing (RF) is a measure of how an agent alters the balance of incoming and outgoing energy in the atmosphere.**
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- **Anesthetic gases are strong greenhouse gases.**

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- Radiative forcing (RF) is a measure of how an agent alters the balance of incoming and outgoing energy in the atmosphere.
- Halogenated organic compounds produce 10-15% of the anthropogenic RF of climate.
- Anesthetic gases are strong greenhouse gases.
- Anesthetic gases are present in miniscule concentrations versus the anthropogenic CO2 from global fossil fuel combustion

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Table 1. Summary of Radiative Properties, Atmospheric Lifetimes, and Global Warming Potentials for Nitrous Oxide and the Halogenated Anesthetic Gases

Compound	Atmospheric lifetime (y)	Radiative efficiency (W m^{-2} ppb^{-1})	GWP			Ozone depletion potential
			20-y time horizon	100-y time horizon	500-y time horizon	
Nitrous oxide, N_2O	114[8]	0.00303[8]	289[8]	298[8]	153[8]	0.017[17]
Halothane, $CF_3CHClBr$	1.0[8]	0.165[a]	190[a]	50[a,b]	20[a]	0.4[a,c]
Enflurane, $CHFClCF_2OCF_2H$	4.3[8]	0.447[a]	2370[a]	680[a,d]	210[a]	0.01[a,c]
Isoflurane, $CF_3CHClOCHF_2$	3.2[13]	0.453[13]	1800[13]	510[13]	160[13]	0.01[a,c]
Desflurane, $CF_3CHFOCHF_2$	14[3]	0.469[13]	6810[3]	2540[3]	130[3]	0[a,c]
Sevoflurane, $(CF_3)_2CHOCH_2F$	1.1[3]	0.351[13]	440[3]	130[3]	40[3]	0[a,c]

GWP = global warming potential.

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GLOBAL WARMING POTENTIAL

- **CO2 = 1**
- **Methane = 21**

- **N2O = 298**
- **Sevoflurane = 130**
- **Desflurane = 2540**

Equivalent driving

- 7 hours in OR
- 2% SEVOFLURANE = 40 km
- 6% DESFLURANE = 1920 km

EDITORIAL

Sustainable Anesthesia

Susan Ryan, PhD, MD,* and Jodi Sherman, MD†

Anesthesiologists put patients first. That is what responsible doctors do. However, the "patient" is more than the human being under our immediate care. The patient includes the family, the neighbors, the community, the country, and the world. Our patient is all of humanity. Accepting responsibility for environmental stewardship puts patients first.

Anesth Analgesia 2012; 114:921

Modern inhalation anesthetics: Potent greenhouse gases in the global atmosphere

Martin K. Vollmer[1], Tae Siek Rhee[2], Matt Rigby[3], Doris Hofstetter[4], Matthias Hill[1], Fabian Schoenenberger[1], and Stefan Reimann[1]

- Results are the first so-called “top-down estimates”—based on actual atmospheric measurements—of how many metrics tons of each anesthetic were released into the atmosphere in 2014

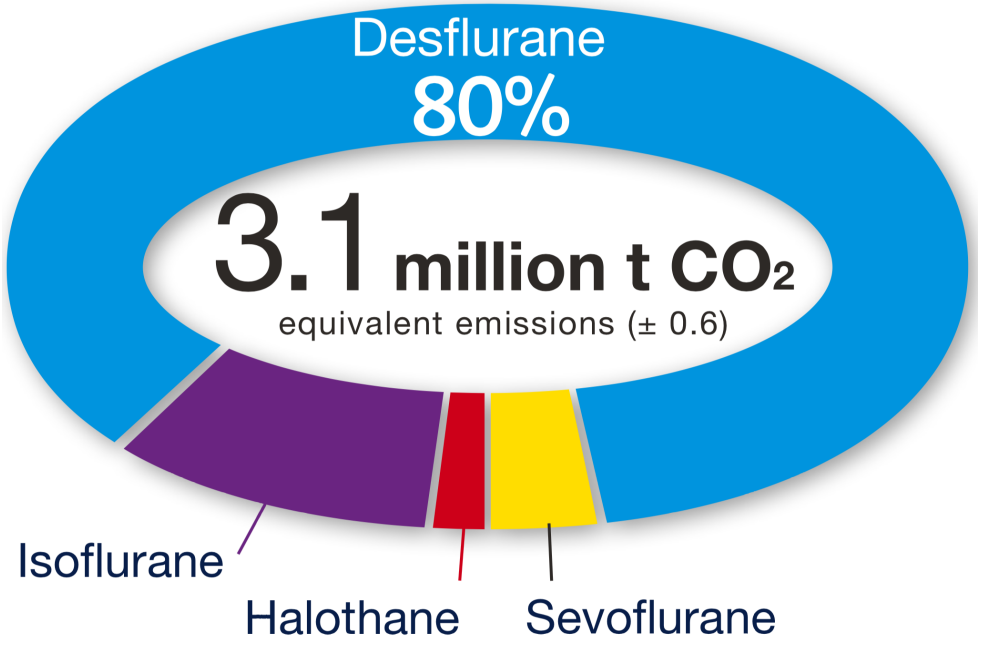
  - Flask samples from remote sites in Northern Hemisphere
  - North Pacific samples aboard an icebreaker research vessel
  - High altitude observatory in Switzerland as an "Atmospheric footprint"
  - South Korean research station in Antartica

Published online 13 MAR 2015

Modern inhalation anesthetics: Potent greenhouse gases in the global atmosphere

Martin K. Vollmer[1], Tae Siek Rhee[2], Matt Rigby[3], Doris Hofstetter[4], Matthias Hill[1], Fabian Schoenenberger[1], and Stefan Reimann[1]

- **Total emissions 2014 : of the 4 anesthetics, 80% Carbon Dioxide equivalent stemming from Desflurane**



Health Sciences North, Sudbury ON

- 12500 cases per year excluding cataracts
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- CO2 eq (CDE) for Sevoflurane is 132,000 km for $91,600 in 2016
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Health Sciences North, Sudbury ON

- 12500 cases per year excluding cataracts
- CO2 eq (CDE) for Sevoflurane is 132,000 km for $91,600 in 2016
- CO2 eq (CDE) for Desflurane is 3,190,000 km for $96,670 in 2016

ELIMINATING DESFLURANE CAN DRAMATICALLY REDUCE YOUR INDIVIDUAL CARBON FOOTPRINT

- In 2013, 35 million Canadians produced 721 Mt CO_2eq
- 20.6 tonnes per capita. Individually release 5-9 tonnes CO_2eq

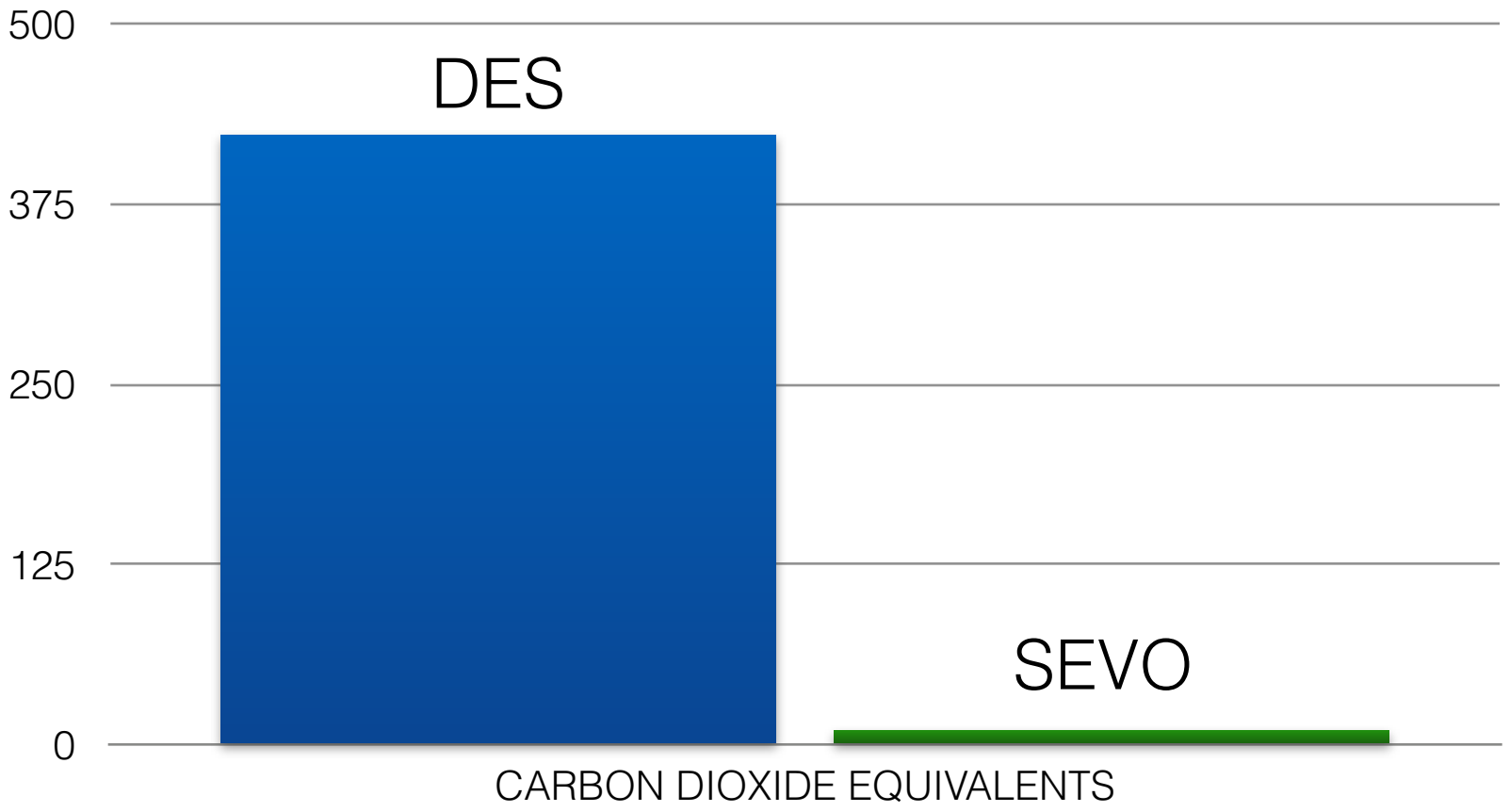
- In 2006 Govt of Canada challenged each individual to reduce their impact by one tonne (One tonne challenge as seen on Rick Mercer!)

- For 225 work days of 7.5 hours , switching from Desflurane to Sevoflurane reduces your impact by 105 tonnes.

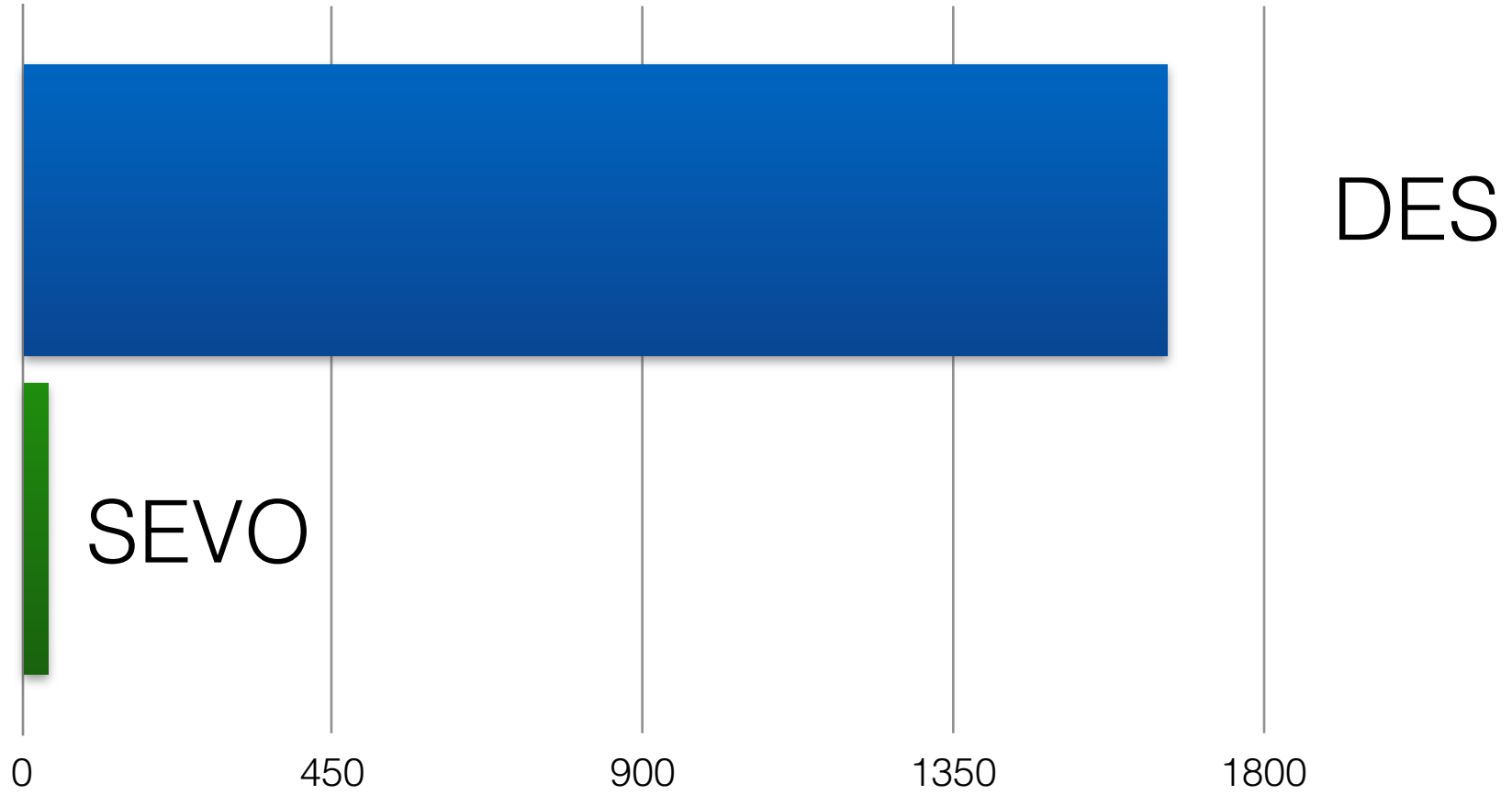
Carbon Footprint of taTME at HSN

- Reviewed all taTME cases Jan 2017 to June 2018 at HSN
- CDE and KmDE were calculated using YALE Gassing Greener app
- Time to reach Aldrete score >9

Comparing CDE Emissions during TATME Procedure



Driving Equivalents in KMs per TATME case



The impact of surgery on global climate: a carbon footprinting study of operating theatres in three health systems

Andrea J MacNeill, Robert Lillywhite, Carl J Brown

Summary

Background Climate change is a major global public health priority. The delivery of health-care services generates considerable greenhouse gas emissions. Operating theatres are a resource-intensive subsector of health care, with high energy demands, consumable throughput, and waste volumes. The environmental impacts of these activities are generally accepted as necessary for the provision of quality care, but have not been examined in detail. In this study, we estimate the carbon footprint of operating theatres in hospitals in three health systems.

Methods Surgical suites at three academic quaternary-care hospitals were studied over a 1-year period in Canada (Vancouver General Hospital, VGH), the USA (University of Minnesota Medical Center, UMMC), and the UK (John Radcliffe Hospital, JRH). Greenhouse gas emissions were estimated using primary activity data and applicable emissions factors, and reported according to the Greenhouse Gas Protocol.

Findings Site greenhouse gas evaluations were done between Jan 1 and Dec 31, 2011. The surgical suites studied were found to have annual carbon footprints of 5 187 936 kg of CO_2 equivalents (CO_2e) at JRH, 4 181 864 kg of CO_2e at UMMC, and 3 218 907 kg of CO_2e at VGH. On a per unit area basis, JRH had the lowest carbon intensity at 1702 kg CO_2e/m^2, compared with 1951 kg CO_2e/m^2 at VGH and 2284 kg CO_2e/m^2 at UMMC. Based on case volumes at all three sites, VGH had the lowest carbon intensity per operation at 146 kg CO_2e per case compared with 173 kg CO_2e per case at JRH and 232 kg CO_2e per case at UMMC. Anaesthetic gases and energy consumption were the largest sources of greenhouse gas emissions. Preferential use of desflurane resulted in a ten-fold difference in anaesthetic gas emissions between hospitals. Theatres were found to be three to six times more energy-intense than the hospital as a whole, primarily due to heating, ventilation, and air conditioning requirements. Overall, the carbon footprint of surgery in the three countries studied is estimated to be 9·7 million tonnes of CO_2e per year.

Interpretation Operating theatres are an appreciable source of greenhouse gas emissions. Emissions reduction strategies including avoidance of desflurane and occupancy-based ventilation have the potential to lessen the climate impact of surgical services without compromising patient safety.

Lancet Planet Health 2017; 1: e381–88

See **Comment** page e357

Division of General Surgery, University of British Columbia, Vancouver, Canada (A J MacNeill MD, Prof C J Brown MD); **Environmental Change Institute, School of Geography and the Environment, University of Oxford, Oxford, UK** (A J MacNeill); **and School of Life Sciences, University of Warwick, Warwick, UK** (R Lillywhite)

Correspondence to: Dr Andrea J MacNeill, Division of General Surgery, Vancouver General Hospital, 950 West 10th Avenue, Vancouver, BC, V5Z 1M9, Canada
andrea.macneill@vch.ca

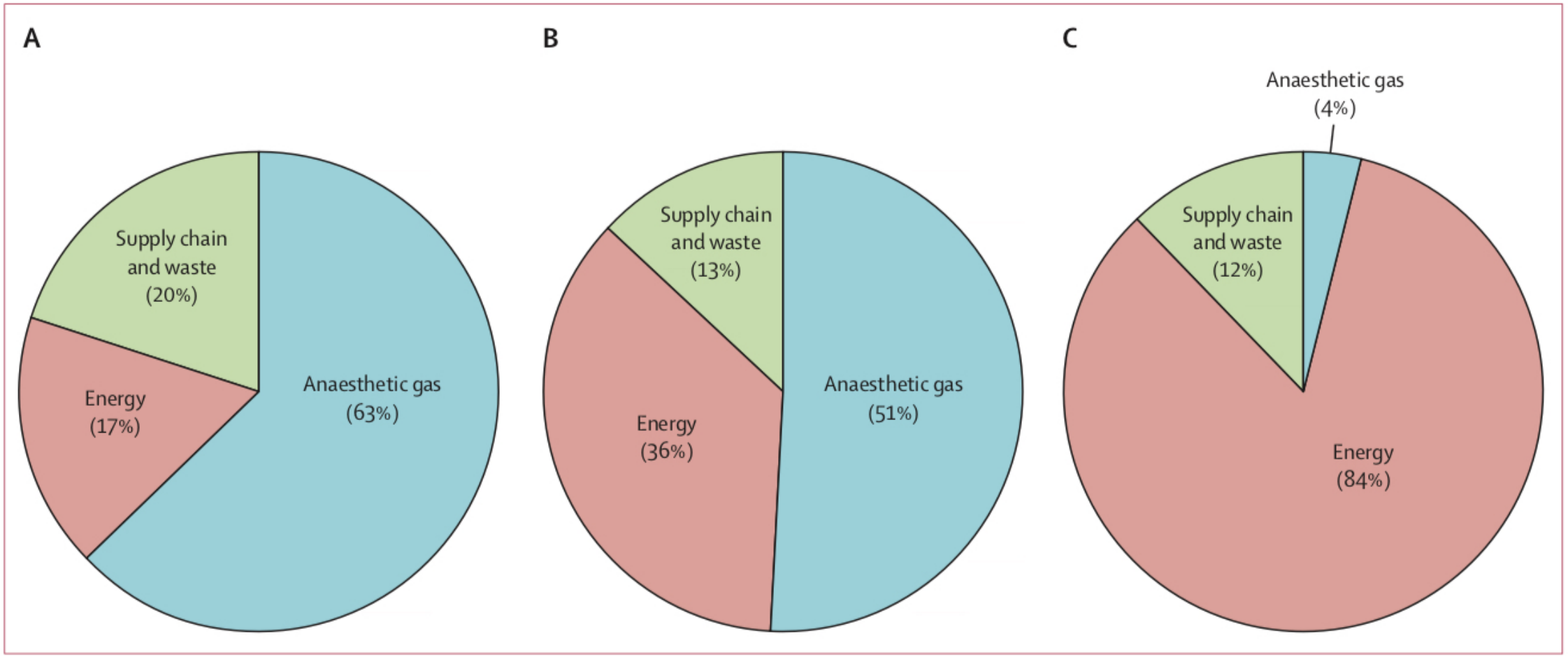
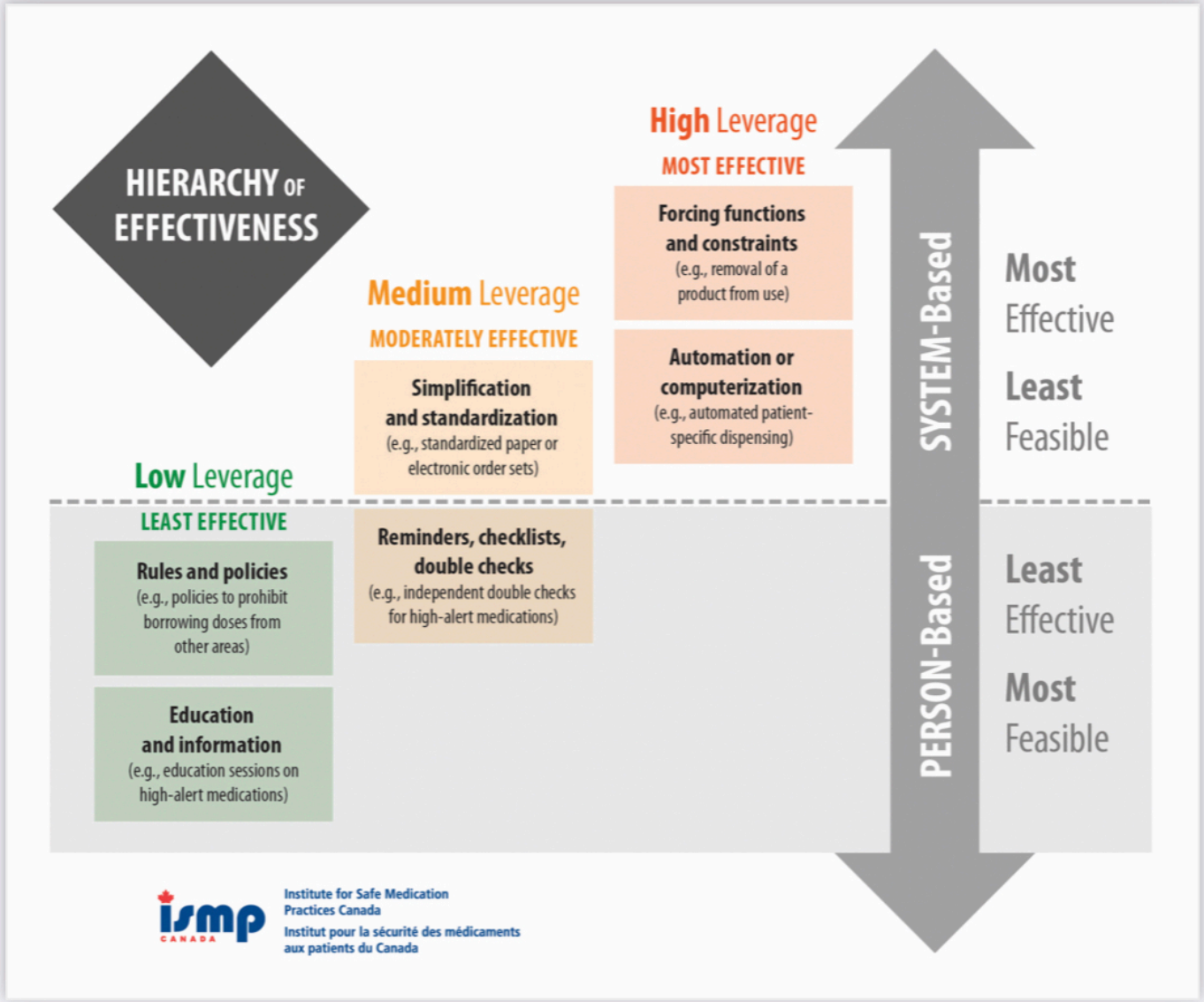


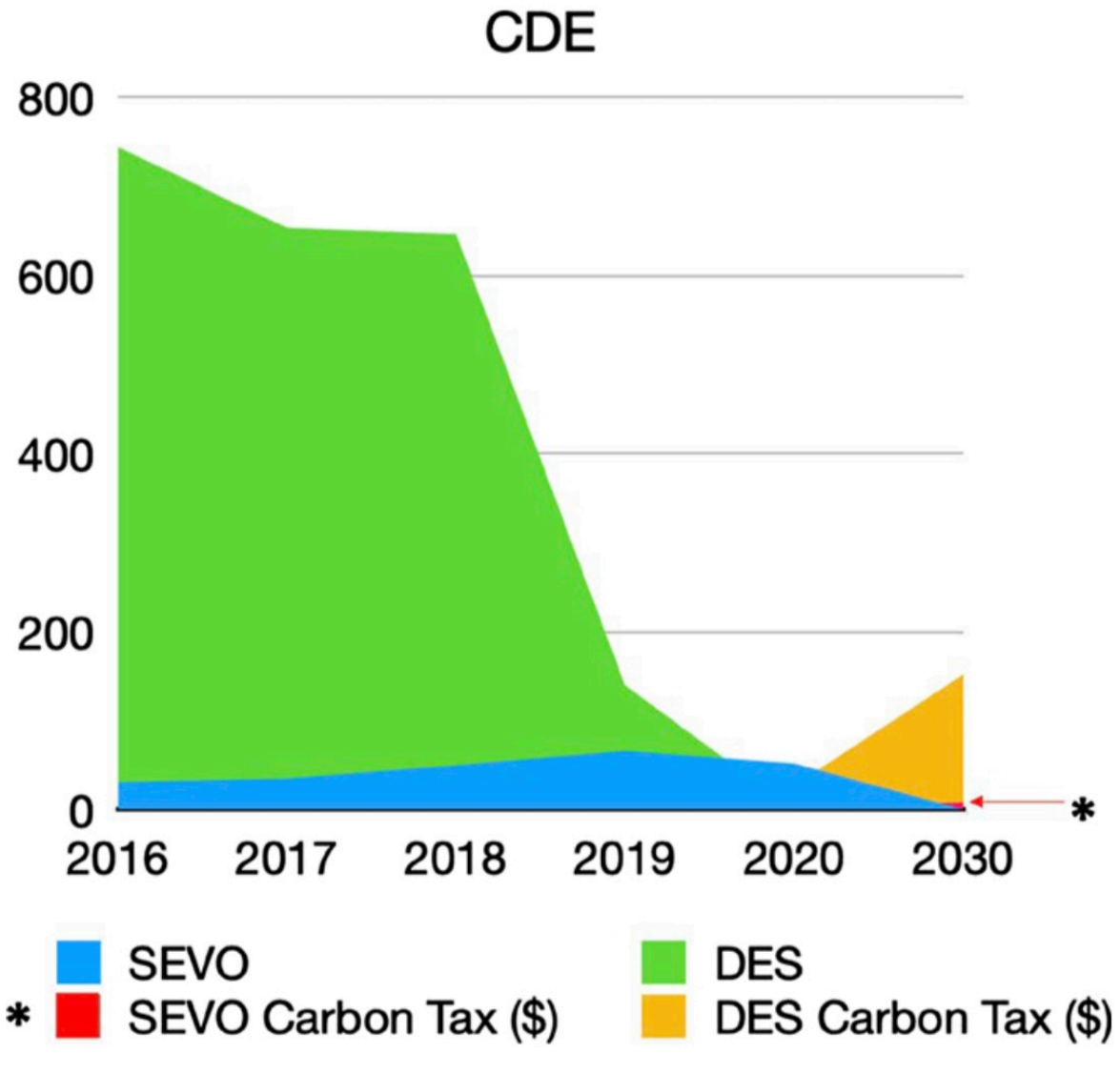
Figure 2: **Relative contribution of scopes 1, 2, and 3 to the carbon footprint of operating theatres at (A) Vancouver General Hospital, (B) University of Minnesota Medical Center, and (C) John Radcliffe Hospital**

Anaesthetic gas=scope 1. Energy=scope 2. Supply chain and waste=scope 3.



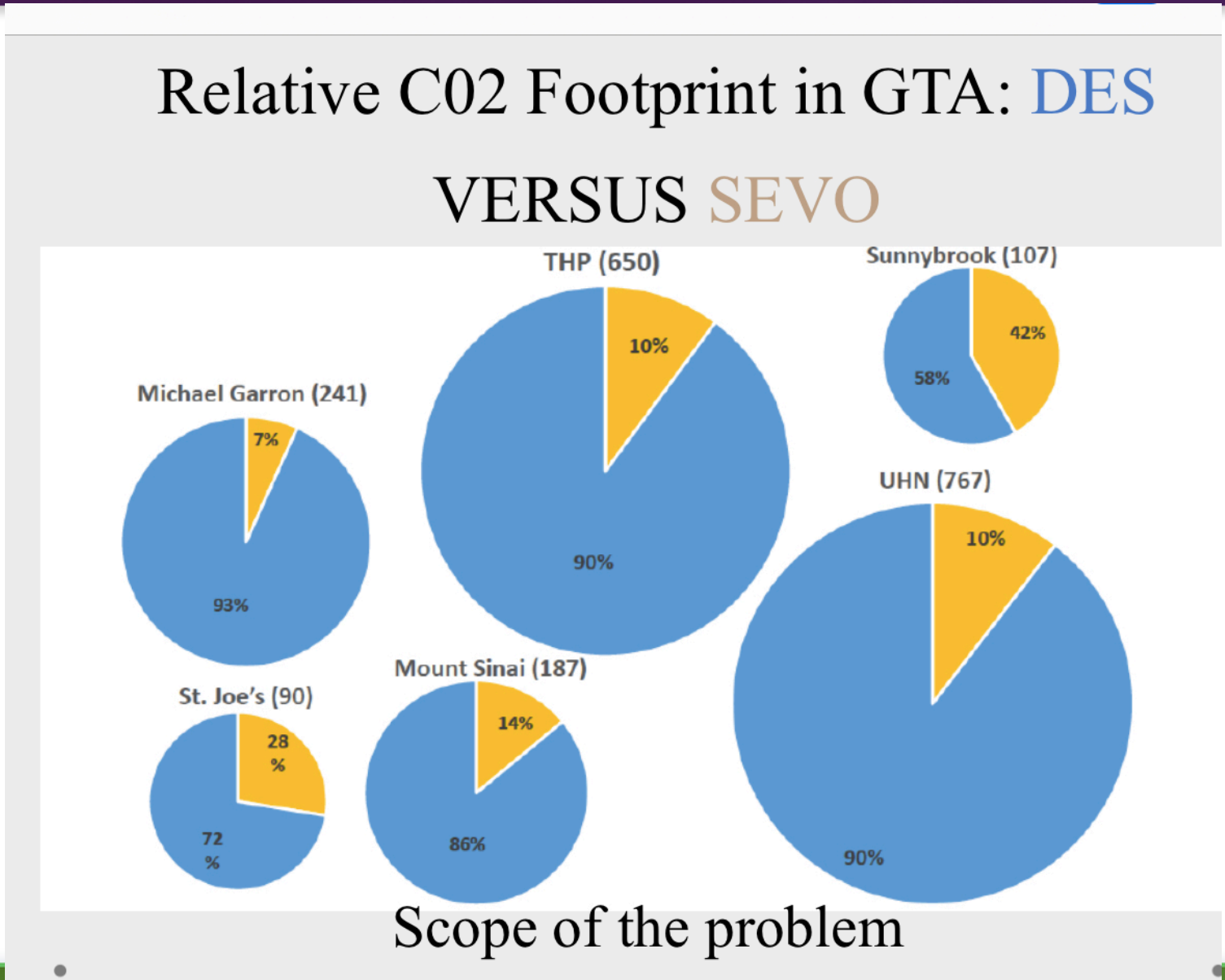
- Educational Sessions
- Warning stickers on Desflurane vapourizer
- Removal of vapourizer on machines
- Forcing Function: remove Desflurane from formulary

Reduction of GHG emissions from HSN

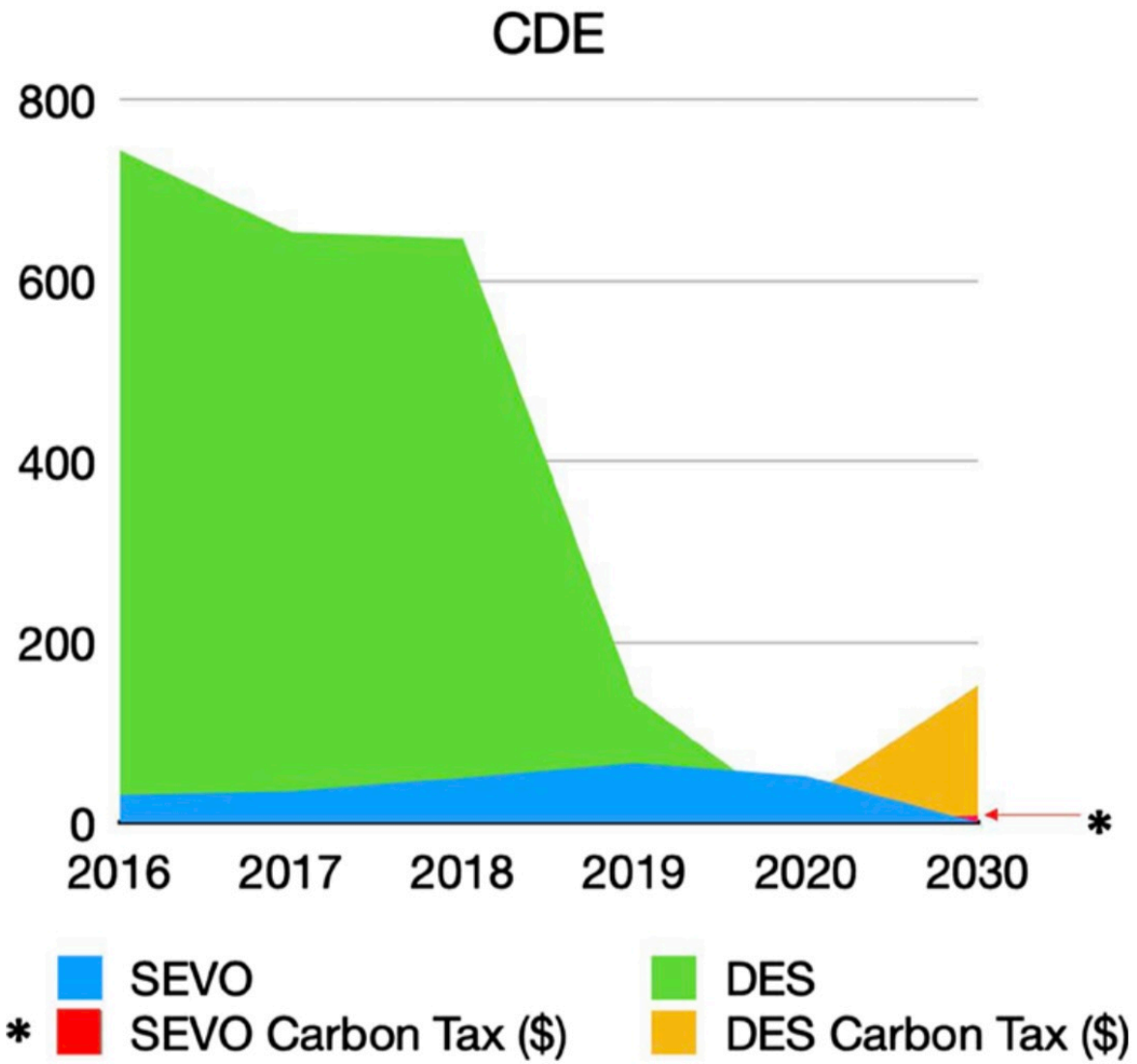


- Reduced annual GHG emissions by over 700 tonnes CDE
- Reduced budget of Anesthetic agents
- No change in morbidity nor mortality discovered and no change in time to discharge from recovery room.

We solved the problem, right?



Pricing Carbon a better Forcing Function?



- **2020 $30/tonne CDE**:
- Sevo increases $1.48 / bottle
- Des increases $26.82 / bottle

- **2030 $170/tonne CDE:**
- Sevo increases $8.39 / bottle
- Des increases $151.98 / bottle

- 2016 purchased 624 bottles Sevo and 832 bottles Des

Canadian Physician, Dr. Howard published in The Lancet a report giving recommendations to reduce the impact of climate change. We would like to go over these Lancet Countdown recommendations with you briefly because we think you can help.

1. Integrate climate change and health into the curriculum of all medical schools
2. Hospitals need to monitor and report heat-related illnesses and deaths across Canada
3. Health organizations like HSN must be proactive in talking about climate change and health
4. Be prepared for the mental health impacts of climate change

The other three recommendations include

5. Enact a strong carbon pricing program. The Canadian Medical Association, Canadian Chamber of Commerce, Energy and Mining leaders support this.
6. Replace coal powered electricity with greener energy
7. Reduce greenhouse gas emissions and retrain the work force.

Inhaled Anesthetic Scrubbing

Deltasorb®

ANESTHETIC COLLECTION SERVICE

The **Deltasorb® Anesthetic Collection Service** is a solution for hospital operating rooms that prevents the routine venting of destructive inhalation anesthetics into the atmosphere. This service also secures a new supply source for generic anesthetics.

The **Deltasorb® Anesthetic Collection Service** is based upon the use of a portable stainless steel **Deltasorb®** canister that is delivered and exchanged weekly to hospitals for a nominal monthly service fee. The anesthetic emission reduction is constantly monitored and reported.

Trained operating room staff install the canister onto the exhaust hose of the scavenging system prior to venting.

The Deltasorb® canister uses a sieve-like filtering matrix known as Deltazite® to selectively adsorb each anesthetic gas as it passes through the canister prior to being vented to the atmosphere.

When the canister is returned to Blue-Zone Technology, the captured anesthetics are extracted from the Deltazite®, liquified and processed into medical grade anesthetics.

The **Deltasorb® Anesthetic Collection Service** enables a complete cradle-to-cradle environmental stewardship in anesthesia delivery.

This technology will revolutionize hospital operating rooms and provide a safe and environmentally friendly way to handle venting of harmful anesthetic gases.

Helping hospitals to go green

Blue-Zone Technologies Ltd. is a growing private Canadian company which is commercializing the innovative Deltasorb® technology, globally.

The company's growth to date has been funded mainly by private capital, the support of the federal government's Sustainable Development Technology Canada (SDTC) program and also in-kind contributions from academia and industry. MARS is contributing with innovative expertise in commercialization.

The Deltasorb® anesthetic collection technology enables hospitals to comply with EPA toxic release regulations and Occupational Health & Safety Standards. It also enables hospitals to showcase their green community partnership with no capital outlay, no retrofits and no new infrastructure. Plus, hospitals qualify for monetary incentives in the form of Carbon Offset Credits and Raw Material Contribution Payback. The use of this technology secures a new source of supply for generic anesthesia.

Blue-Zone has successfully implemented the Deltasorb® Anesthetic Collection Service in over 200 operating rooms across Ontario, Canada.

To install the Deltasorb® Anesthetic Collection Service at your hospital or for more information call (905) 761-1224 or visit bluezone.ca

Saving our neighborhoods... every day!

ASK OF POLITICIANS

- **Anesthetic gases be added to GHG inventory and thus subject to carbon pricing mechanism**

Carbon footprint

- 2-2.5% of total GHG from Canadian coal plants

- Potential to reduce 1 Mt CDE (730 Mt total) but big reduction in anthropogenic radiative forcing