
Vapeurs anesthésiques

Impact écologique des systèmes de santé

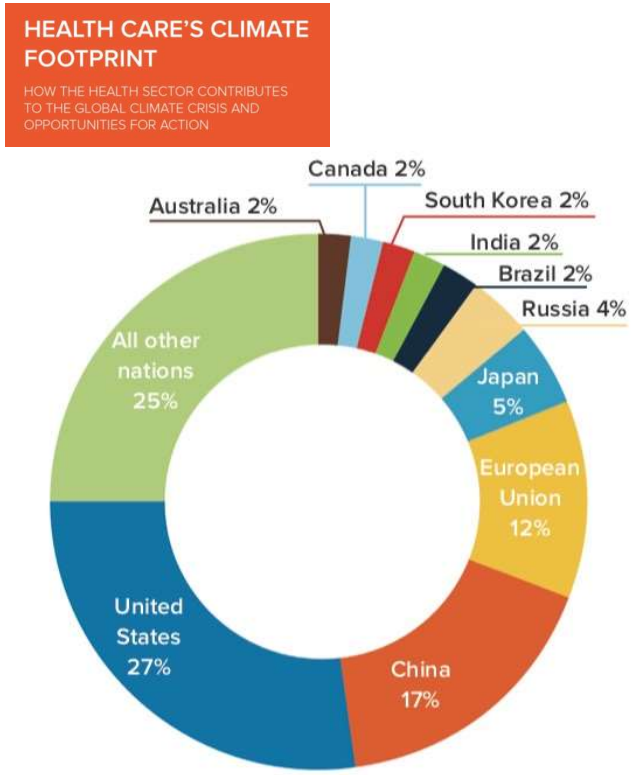


Figure 8: Top ten emitters plus all other nations as percentage of global health care footprint.

2.0GtCO2e en 2014,
Equivalent 4.4% des émissions de GES total.

	Health care country/region emissions by ranking	Total country/region emissions by ranking
1	United States	China
2	China	United States
3	European Union	European Union
4	Japan	India
5	Russia	Russia
6	Brazil	Japan
7	India	Brazil
8	South Korea	Canada
9	Canada	South Korea
10	Australia	Mexico
	Mexico (11)	Australia (17)

Table 1: Top ten health care carbon emitters compared to total top ten emitters

- Rapport SEPTEMBRE 2019 HCWH (Health Care World Harm)

Impact écologique des systèmes de santé

HEALTH CARE'S CLIMATE FOOTPRINT

HOW THE HEALTH SECTOR CONTRIBUTES TO THE GLOBAL CLIMATE CRISIS AND OPPORTUNITIES FOR ACTION

France health care	Value	Unit
Climate footprint	29	$MtCO_2e$
Emissions per capita	0.44	tCO_2e/capita
Emissions as % of national footprint	4.6	%
Expenditure per capita	5010	USD
Expenditure as percentage of GDP	11.6	%
% of footprint generated domestically	48.8	%
Health sector footprint equivalence to coal power plant emissions[1]	7	coal-fired power plants in one year
Health sector footprint equivalence to tanker trucks' worth of gasoline[1]	383,905	tanker trucks' worth of gasoline
Health sector footprint equivalence to passenger vehicles driven for one year[1]	6,157,113	passenger vehicles driven for one year

- Rapport SEPTEMBRE 2019 HCWH (Health Care World Harm)

Impact écologique des systèmes de santé

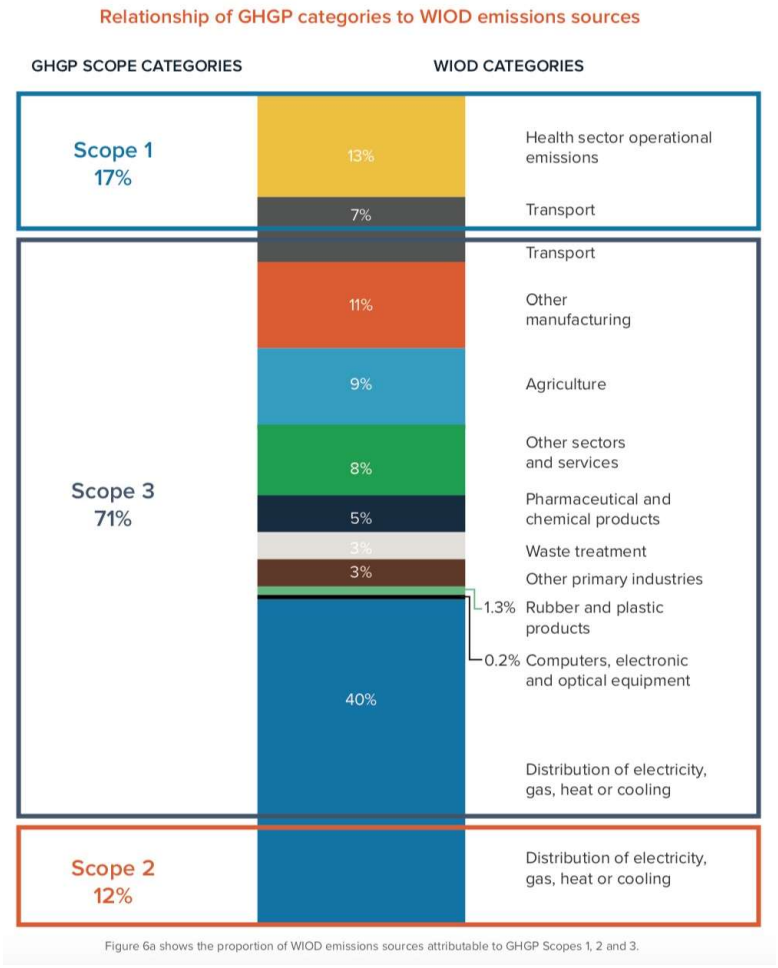
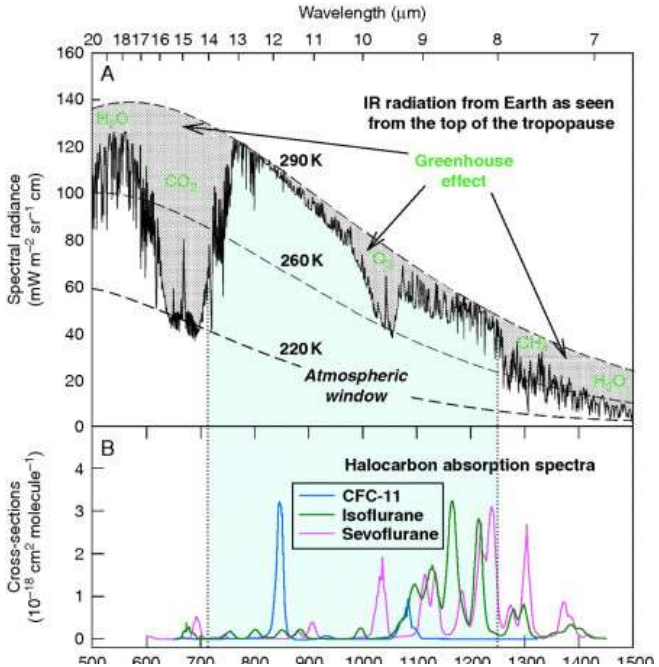
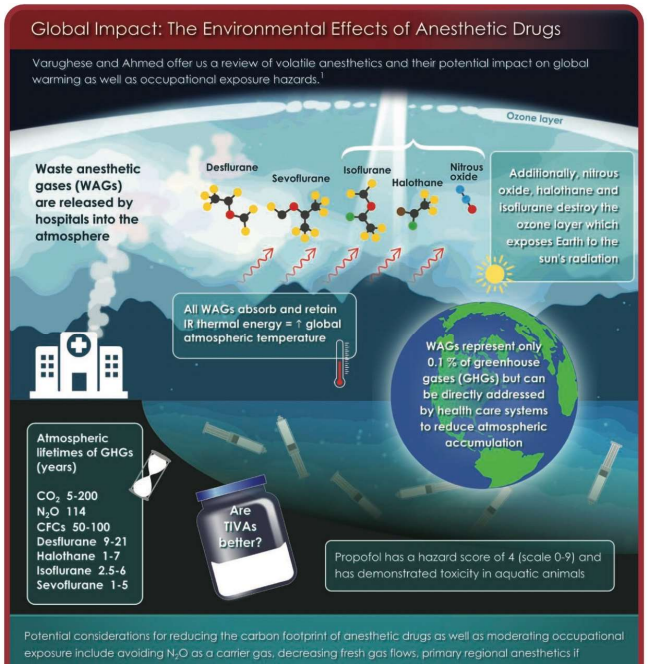


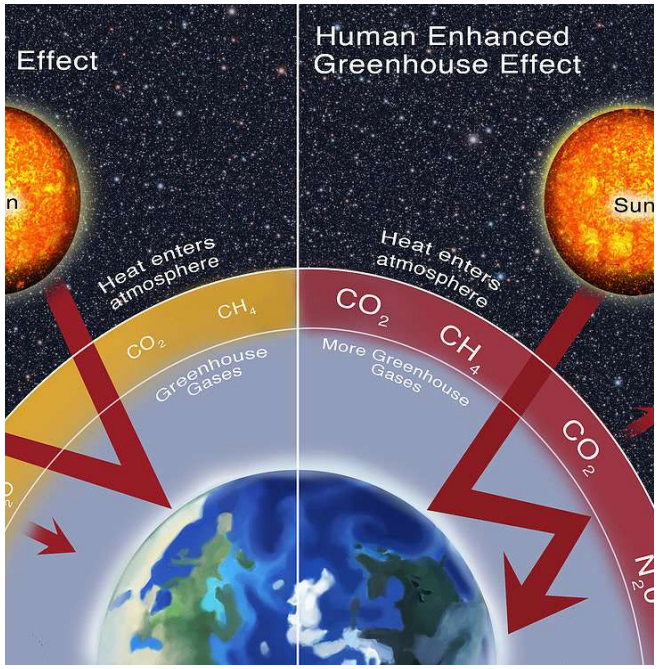
Figure 6a shows the proportion of WIOD emissions sources attributable to GHGP Scopes 1, 2 and 3.

HEALTH CARE'S CLIMATE FOOTPRINT

HOW THE HEALTH SECTOR CONTRIBUTES TO THE GLOBAL CLIMATE CRISIS AND OPPORTUNITIES FOR ACTION







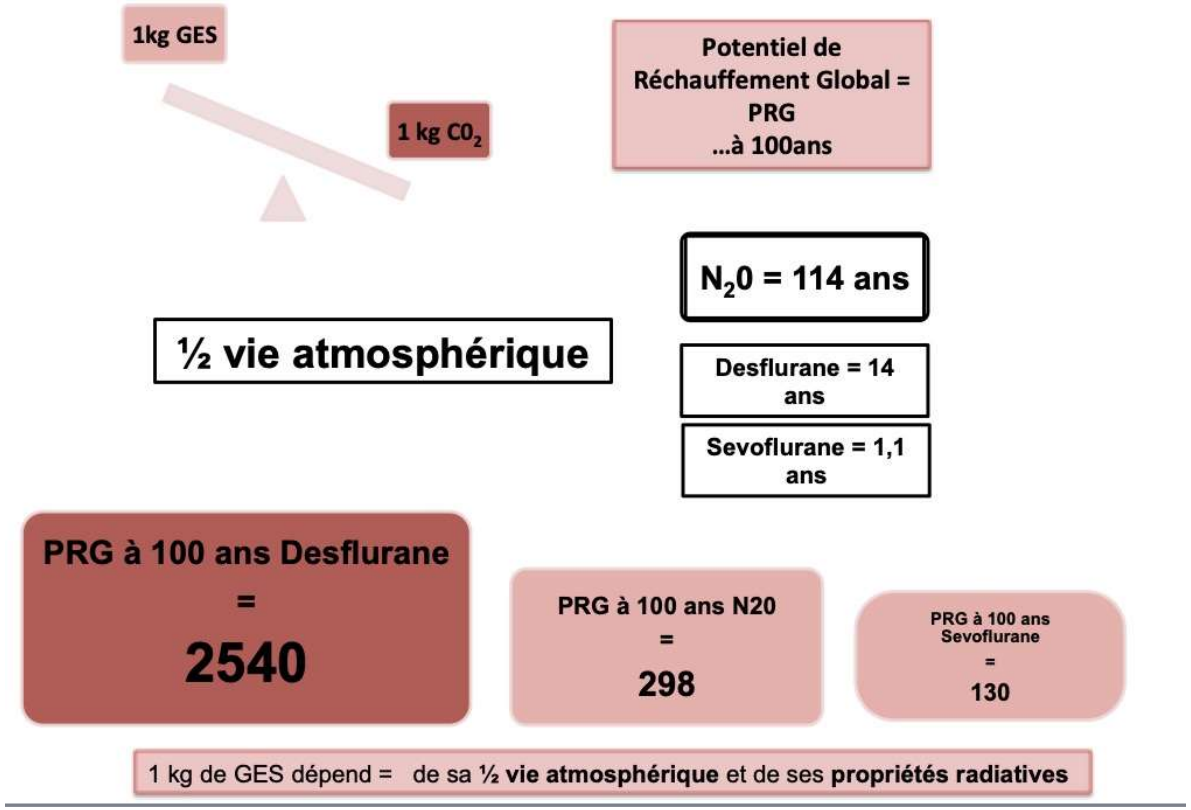
Vapeurs (gaz) anesthésiques = GAZ A EFFET DE SERRE

Contribution des gaz d'anesthésie au réchauffement climatique : 1 année de production mondial de vapeurs d'anesthésie = 1 millions de voitures

- *Anesthesia & Analgesia - October 2021 • Volume 133 • Number*

Impact écologique de l'anesthésie inhalée

- PRG : Potentiel de Réchauffement Global



Impact écologique des systèmes de santé

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

Lancet Planet Health 2017;

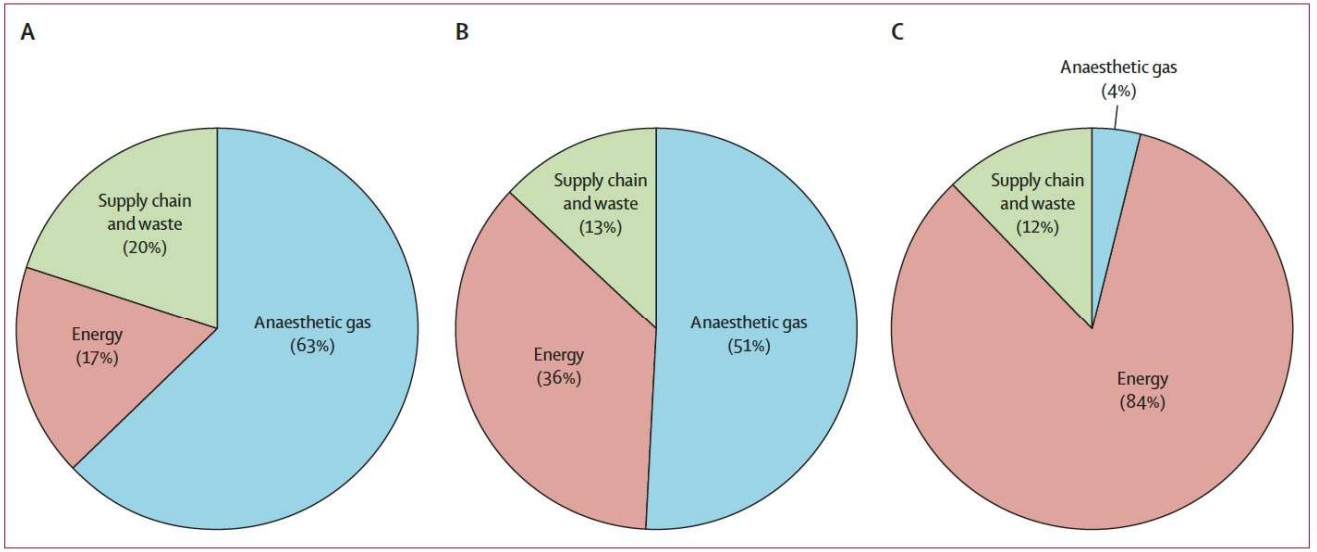


Figure 2: **Relative contribution of scopes 1, 2, and 3 to the carbon footprint of operating theatres at (A) Vancouver General Hospital, (B) University of Minnesota Medical Center, and (C) John Radcliffe Hospital**

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

Réduire l'impact écologique de l'anesthésie inhalée

Coût Carbone Total

Des/Sevo à 1MAC pendant 1 heure
60% 02 / 40% N_2O
DGF 1L/min Desflurane
DGF 2/L min Sevoflurane

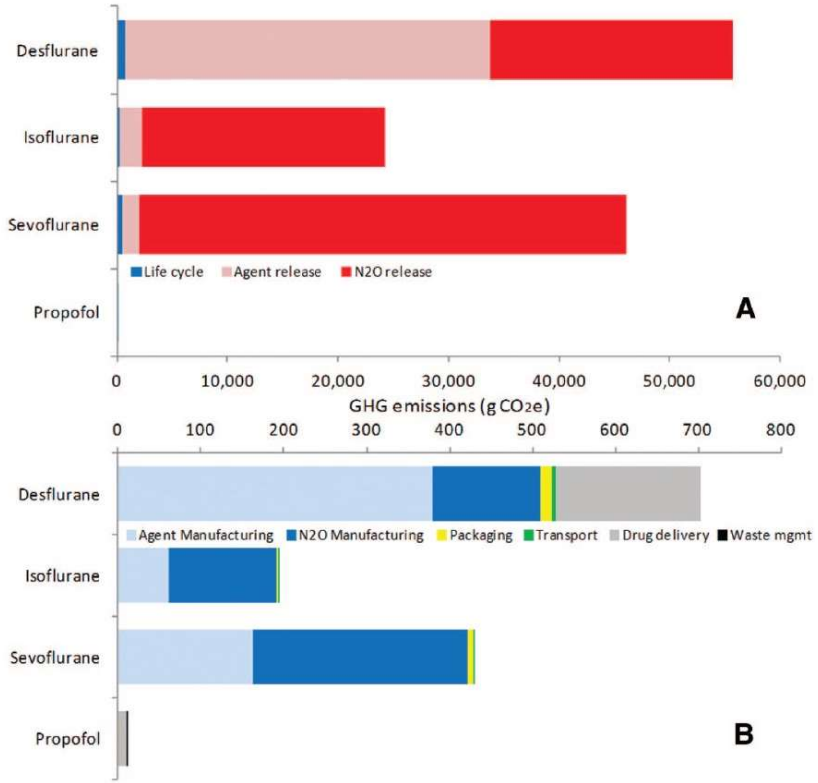


Figure 1. Life cycle greenhouse gas (GHG) emissions of anesthetics, (A) including waste anesthetic gas emissions of halogenated drugs and nitrous oxide (N_2O) and (B) excluding waste anesthetic gas emissions.

Sherman et al., Anesth Analg, 2012

Réduire l'impact écologique de l'anesthésie inhalée

Desflurane Should Des-appear: Global and Financial Rationale

Matthew J. Meyer, MD

A

Volatile Anesthesia (MAC)	FGF (L / min)	CDE20[3] (g / MAC-hour)	Social Cost[29] of Anesthetic Emissions ($ / MAC-hour)
Sevoflurane (2%)	2	6,980	$3
Isoflurane (1.2%)	0.5	3,881	$2
Isoflurane (1.2%)	1	7,762	$3
Isoflurane (1.2%)	2	15,551	$6
Desflurane (6%)	0.5	46,796	$20
Desflurane (6%)	1	93,593	$39
Desflurane (6%)	2	187,186	$78

B

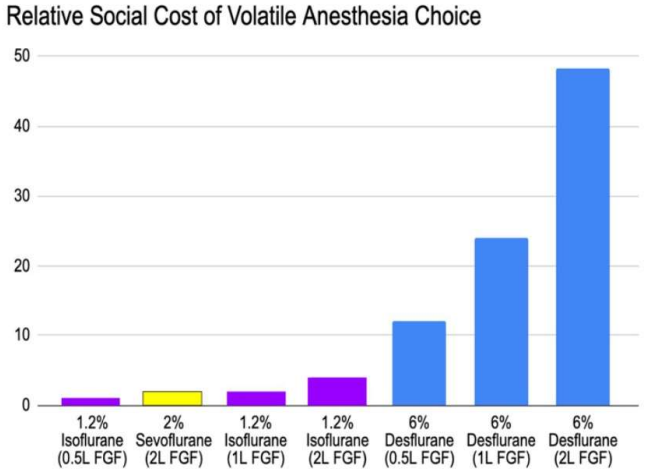


Figure 1. Global social cost of volatile anesthesia choice. The global social cost (expected economic damage) of carbon dioxide has recently been estimated at a median of $417 per ton. A, The social cost of anesthetic emissions is calculated for different volatile agents and different FGF. B, The social cost of anesthetic emissions is normalized to the option with the lowest social cost per MAC-hour (isoflurane at half a liter of FGF). Notably, data for sevoflurane were only available for 2 L of FGF and not for lower flows. CDE 20 indicates carbon dioxide equivalents over 20 y; FGF, fresh gas flow; MAC-hour, minimum alveolar content per hour (measure of anesthesia that 50% of patients will not respond to surgical stimulus).

Impact écologique de l'anesthésie inhalée

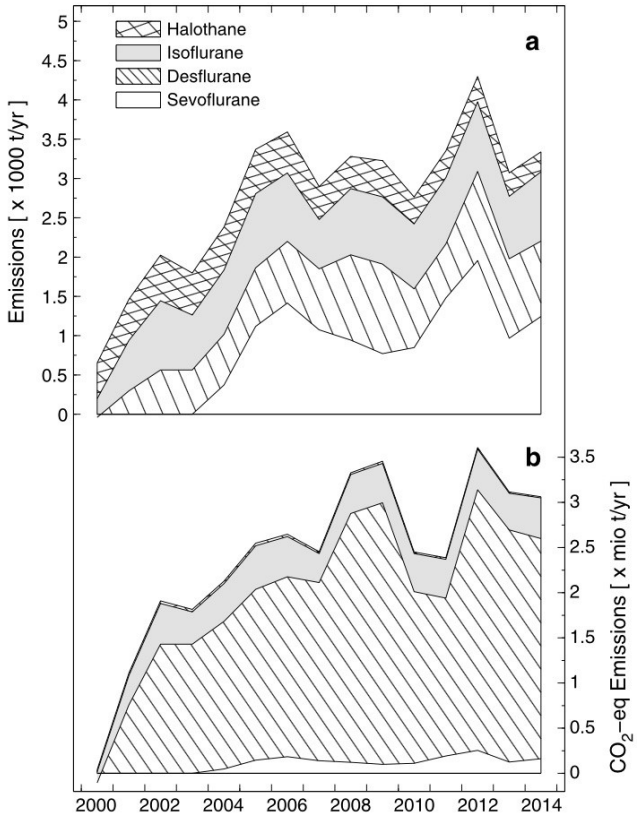
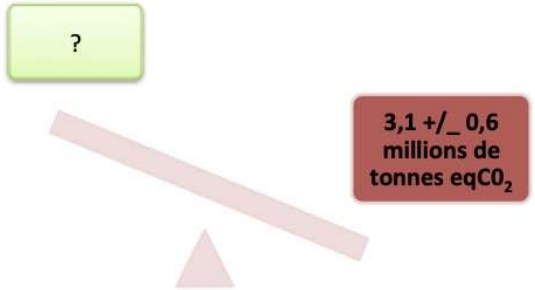


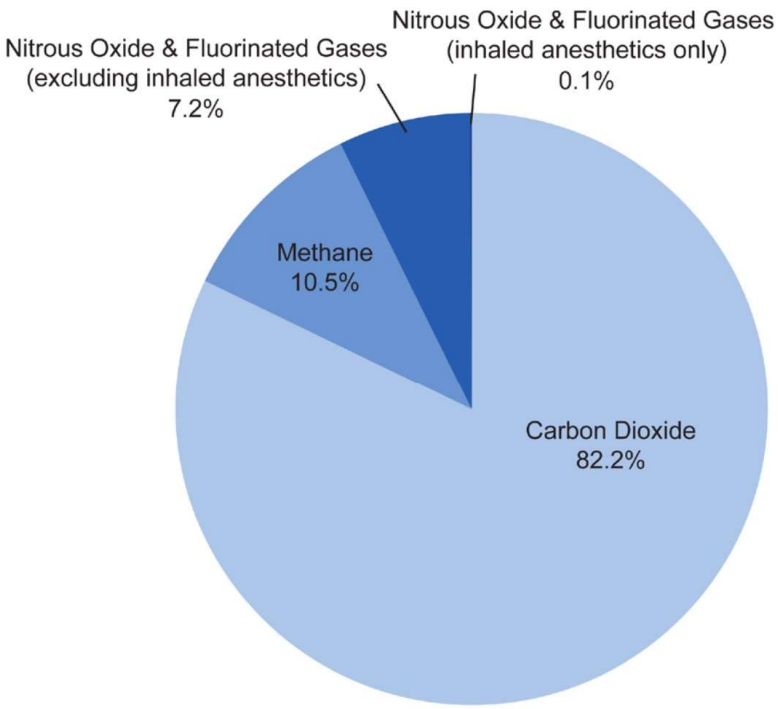
Figure 2. Global emissions of inhalation anesthetics: (a) emissions on a per-ton basis of the anesthetics halothane, isoflurane, desflurane, and sevoflurane and (b) emissions in units of CO_2 equivalents using Global Warming Potentials (GWPs) based on a 100 year time frame.



Mesure concentrations volumiques Gaz d'anesthésie

Gaz d'anesthésie = Gaz à effet de serre

US GHG Emission



5,6 millions tEqC02

Figure 1. The total annual US GHG emission in 2012 was 6.2 gigatons of CO_2 equivalent, of which 6.8% comprised N_2O (4.3%) and fluorinated gases (3%; hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride, and nitrogen trifluoride).[4] The contributions of inhaled anesthetics (N_2O, desflurane, isoflurane, and sevoflurane) to US GHG emissions for 2011–2013 were estimated to be 5.6 million tons of CO_2 equivalent (excluding dental, laboratory, and veterinary medicine),[5,6] comprising approximately 1% of GHG emissions from the US health care sector[6] and approximately 0.1% of total US GHG emissions.[4,6] GHG indicates greenhouse gas.

Réduire l'impact écologique de l'anesthésie inhalée

HEALTH CARE'S CLIMATE FOOTPRINT

HOW THE HEALTH SECTOR CONTRIBUTES TO THE GLOBAL CLIMATE CRISIS AND OPPORTUNITIES FOR ACTION

Anesthetic Gases

The gases used for anesthesia are potent greenhouse gases. Commonly used anesthetics include nitrous oxide and the fluorinated gases sevoflurane, isoflurane, and desflurane. Global warming potentials range between 130 $kgCO_2e/kg$ (sevoflurane) and 2540 $kgCO_2e/kg$ (desflurane). At present, the majority of these gases enter the atmosphere.[29]

Research by the NHS Sustainable Development Unit indicates that the United Kingdom's anesthetic gas footprint is 1.7% and the majority can be attributed to nitrous oxide use.[30] Available data on the medical consumption of nitrous oxide for anesthesia is not global. UNFCCC reports for a subset of developed nations within its Annex 1 grouping.[27] Medical nitrous oxide use for these nations totalled 7 $MtCO_2e$, presenting an additional 0.4% to the global healthcare footprint, and an additional 2.5% on the global Scope 1 footprint. Together, these nations accounted for 15% of the global population, 57% of the global GDP, and 73% of global health expenditure in 2014, and so the full impact of nitrous oxide use in anesthesia on the global health care footprint can be expected to be substantially greater than the figures for Annex 1 nations alone.

- Rapport SEPTEMBRE 2019 HCWH (Health Care World Harm)

Réduire l'impact écologique de l'anesthésie inhalée

For regions where full coverage is available in the UNFCCC data, nitrous oxide anesthesia adds an additional 0.7% to the North American and 1.0% to the European Union's health care footprint.

For fluorinated gases used in anesthesia, global emissions to atmosphere in 2014 was estimated to be $3.1 \pm 0.6 MtCO_2e$[27]. This figure presents an additional 0.2% on the global health care footprint. Due to increasing uptake of these gases, increasingly preferred to nitrous oxide, the footprint from anesthetic gases can be expected to increase.

Anesthetic gases therefore contribute at least 0.6% of health care's global climate impact. Wider adoption of waste anesthetic capture systems has the potential to be a high impact health care-specific climate mitigation measure.

- Rapport SEPTEMBRE 2019 HCWH (Health Care World Harm)

Agir… maintenant !

Réduire l'impact écologique de l'anesthésie inhalée

MESURE N° 1 : Baisser les DGF et/ou utiliser l'AINOC

MESURE N° 2 : Choix judicieux des halogénés

MESURE N° 3 : Diminuer l'utilisation du N20

Réduire l'impact écologique de l'anesthésie inhalée

MESURE N° 1 : Baisser les DGF et/ou utiliser l'AINOC

1865 AG avec DGF manuel vs **1810 AG Avec AINOC**

AINOC
= 44 % émission de GES en moins

(- 27% des coûts)

Tay et al. Anaesth Intensive Care, 2013

Réduire l'impact écologique de l'anesthésie inhalée

MESURE N° 1 : Baisser les DGF et/ou utiliser l'AINOC

AINOC

Dieu et al., Ann Fr Anesth Réanimation, 2013
Singaravelu et al., Br J Anaesth, 2013

Economie horaire en gaz divisé par 2 = - 47 000 euros/an

Struys et al., Br J Anaesth, 2005
Lortat-Jacob et al., Anaesthesia, 2009

Economie horaire en sevoflurane divisé par 2, desflurane divisé par 3

Réduire l'impact écologique de l'anesthésie inhalée

Coût Carbone Total

Des/Sevo à 1MAC pendant 1 heure
60% 02 / 40% N_2O
DGF 1L/min Desflurane
DGF 2/L min Sevoflurane

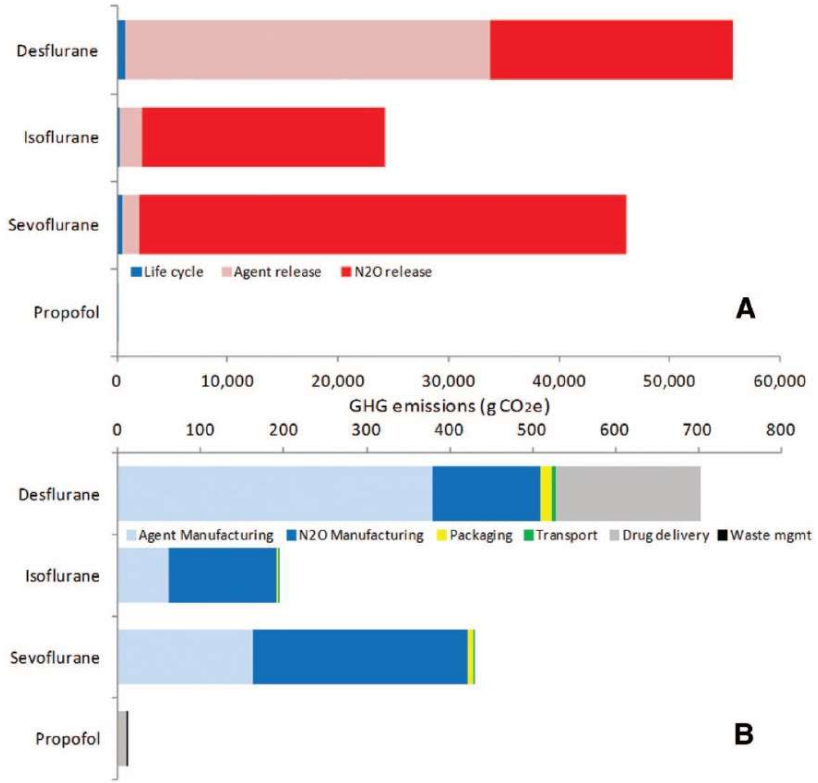


Figure 1. Life cycle greenhouse gas (GHG) emissions of anesthetics, (A) including waste anesthetic gas emissions of halogenated drugs and nitrous oxide (N_2O) and (B) excluding waste anesthetic gas emissions.

Sherman et al., Anesth Analg, 2012

MESURE N° 2 : Choix judicieux des halogénés

Quel est l'impact écologique des gaz d'anesthésie ? [2]

MESURE N° 2 : Choix judicieux des halogénés

BJA

British Journal of Anaesthesia, xxx (xxx): xxx (xxxx)

doi: 10.1016/j.bja.2020.09.013
Advance Access Publication Date: xxx
Editorial

EDITORIAL

Desflurane in modern anaesthetic practice: walking on thin ice(caps)?

Clifford L. Shelton[1,2,*], Rebecca Sutton[3] and Stuart M. White[4]

Table 1 Meta-analyses of RCTs comparing time with emergence, tracheal extubation and PACU discharge of patients anaesthetised with desflurane, sevoflurane, or propofol TIVA. *Removal of supraglottic airway. NS, not significant; NR, not reported; PONV, postoperative nausea and vomiting.

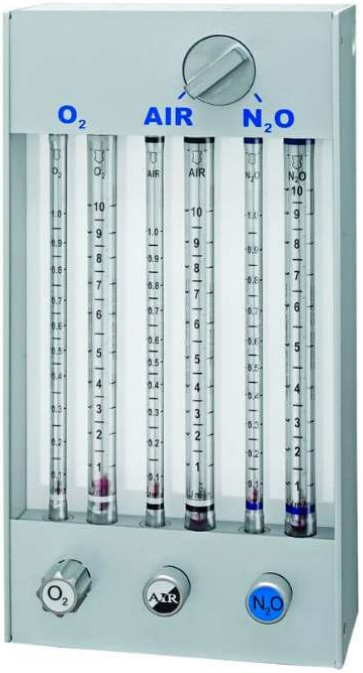
Study	Context	Desflurane *vs* sevoflurane			Desflurane *vs* propofol			Notes
		Emergence (min)	Extubation (min)	PACU discharge (min)	Emergence (min)	Extubation (min)	PACU discharge (min)	
Gupta and colleagues[10]	Adult patients. Ambulatory surgery	−<1	−<1	+6	−1.3	NR	NR	Less PONV in propofol group.
Macario and colleagues[11]	Adult and paediatric patients. Ambulatory and inpatient surgery	−1.7	−1.3	NS	NR	NR	NR	No difference in PONV between groups.
Liu and colleagues[12]	Patients with BMI >30 kg m^{-2}. Ambulatory and inpatient surgery	−3.1	−3.9	+1.28	−10.7	−13.2	NR	No difference in PONV or analgesic requirement between groups.
Stevanovic and colleagues[13]	Adult patients. Laryngeal mask airway	−3.8	−0.7*	NR	NR	NR	NR	No difference in cough or laryngospasm between groups.
Lim and colleagues[14]	Paediatric patients. Ambulatory surgery.	−2.7	−2.2	NR	NR	NR	NR	No difference in incidence or severity of emergence agitation between groups.
Guo and colleagues[15]	Paediatric patients. Ambulatory and inpatient surgery	NS	−3.3	NS	NS	−3.83	NS	No difference in PONV or analgesic requirement between groups. Less emergence agitation with propofol *vs* desflurane or sevoflurane.

Réduire l'impact écologique de l'anesthésie inhalée

MESURE N° 3 : Diminuer l'utilisation du N20

N_2O

- **Coût carbone ++**
- **Destructeur couche Ozone ++**
- **Demi vie 114 ans**
- **N_2O médical = 10% N_2O total**
- **Bloc « free »**



Réduire l'impact écologique de l'anesthésie inhalée

CHU Hôpitaux de Bordeaux

	SEVOFLURANE					
	Flacons (250mL)	Volume (L)	Masse (kg)	EqCO2 (kg)	Eq. Km parcourus*	Coût (en euros)
CFXM	356	89	135	17 586	125 617	28 214
Orthopédie Urovasculaire Neurochirurgie	555	139	211	27 417	195 836	44 004
Digestif & Thoracique	293	73	111	14 474	103 387	23 291
Ambulatoire	16	4	6	790	5 646	1 270
Gynécologie & Obstétrique	91	23	35	4 495	32 110	7 212
Bloc des Urgences	208	52	79	10 275	73 394	16 489
Bloc Pédiatrique	326	82	124	16 104	115 031	25 830
Bloc des Brulés	80	20	30	3 952	28 229	6 360
Imagerie	62	16	24	3 063	21 877	4 907
Total	**1 987**	**497**	**755**	**98 158**	**701 127**	**157 578**

	DESFLURANE					
	Flacons (250mL)	Volume (L)	Masse (kg)	EqCO2 (kg)	Km parcourus*	Coût (en euros)
CFXM	24	6	8	21 360	152 574	1 932
Orthopédie Urovasculaire Neurochirurgie	65	16	23	57 851	413 222	5 253
Digestif & Thoracique	23	6	8	20 470	146 217	1 845
Ambulatoire	23	6	8	20 470	146 217	1 865
Gynécologie & Obstétrique	53	13	19	47 171	336 935	4 283
Bloc des Urgences	7	2	2	6 230	44 501	569
Total	**195**	**47**	**68**	**173 553**	**1 239 665**	**15 746**

Réduire l'impact écologique de l'anesthésie inhalée

Fiche de bon usage des agents halogénés (AH) - CHU de Bordeaux

CHOIX AH	INDUCTION	ENTRETIEN	REVEIL
Pollution DES >>SEVO **Sevoflurane** • Pédiatrie • Induction inhalatoire • Masque laryngé • Asthmatique, bronchitique **Desflurane** • Obèse (IMC>35)	Mode VS AI PEP F_iO2 100% **DGF 6 à 8L/min** puis **DGF < 1L/min** dès intubation F_iO_2 = 30%	**Privilégier AINOC** Si Réglage manuel : • **DGF < 1L/min** • Ouverture évaporateur saturation initiale par haute F_D sans ouvrir le DGF **Réglages alarmes F_iO_2/F_eO_2 ++**	F_iO2 100% **Fermeture de la cuve halogéné au plus tôt** Ouverture circuit en fin de procédure (si patient décurarisé)

CHU Hôpitaux de Bordeaux

F_iO_2: fraction inspirée en O2
F_DO_2: fraction délivrée en O2
F_eO_2: fraction expirée en O2
F_D: fraction délivrée agent halogéné

Evaluation des Pratiques Professionnelles n° 455
« Réduction de l'impact écologique des gaz d'anesthésie des blocs opératoires du CHU de Bordeaux »

Gauthier GRESS, Dr Jean-Claude PAUCHARD, Pr Karine Nouette-Gaulain
Service Anesthésie Réanimation Pellegrin – CHU de Bordeaux

Réduire l'impact écologique de l'anesthésie inhalée

Anaesth Crit Care Pain Med 39 (2020) 685–687

Letter to the Editor

Reducing the greenhouse gas emissions from halogenated agents in daily clinical practice: An audit at the University Hospital of Bordeaux

Table 2
Consumption and related ecological cost of volatile agents during Phase I and Phase III.

Variable	Phase I	Phase II	% reduction
Interventions	11,414	11,192	
Desflurane			
Bottles (n)	113	72	36
Volume (L)	28	18	
Cost (€)	2209	1408	
CO_2-eq (kg)	104,515	66,620	
Driving distance (Km)	941,576	600,180	
Sevoflurane			
Bottles (n)	1208	932	23
Volume (L)	302	233	
Cost (€)	25,061	19,329	
CO_2-eq (kg)	59,663	46,016	
Driving distance (Km)	537,504	414,558	

Results are expressed as number (n), Liter (L), euros (€), kilogram (kg), Km : kilometre CO_2-eq: carbon dioxide equivalent. Calculation of carbon dioxide equivalent can be converted into driving distance expressed in kilometre. In France in 2017, passenger cars currently emit an average 111 g CO_2 emissions/km.

Jean-Claude Pauchard[a,b,c], Gauthier Gress[b,c], Matthieu Biais[b,c,d], Hélène Beloeil[c,e], Karine Nouette-Gaulain[b,c,f,*]
[a]*Polyclinique Aguilera Groupe Ramsays GDS, Anesthésie Réanimation, 64200 Biarritz, France*

Réduire l'impact écologique de l'anesthésie inhalée

CHU Hôpitaux de Bordeaux — université de BORDEAUX

EPP n°455 : Réduction de l'impact écologique des gaz d'anesthésie des blocs opératoires du CHU de Bordeaux

1er quad. 2017 vs 1er quad 2018

DGF : 2,3 à 1,2 L/min

AINOC : 31 à 42 %

- 23% **-36%**

= **78 181 EqKgC02**

(- 370 000 km)

En cours / à venir..

Ramsay Santé
Nos engagements

Nos engagements
Planète

Pour une pratique médicale éco-responsable :
Réduisons les gaz à effet de serre au bloc opératoire

LE SECTEUR DE LA SANTÉ EST RESPONSABLE DE 4,6% des émissions de carbone en France

Ramsay Health Care

Home | Find a Service | Find a Specialist | Careers | Sustainability | News | Research

Patient Safety and Quality
Workplace Health & Safety

Corporate Social Responsibility

Greening theatres

Ramsay has commenced a concerted sustainability push in our operating theatres.

For example, Ramsay Santé has launched an awareness and information campaign to encourage anaesthesiologists to reduce their carbon footprint.

"The anaesthesia gases used in the operating room are in fact greenhouse gases," explained Dr Jean-Claude Pauchard, an anaesthesiologist-intensive care physician at the Aguilera Clinic in Biarritz.

"Once inhaled, very little is metabolised by the patient. Therefore, 95% of the gases are released into the atmosphere."

Anaesthesiologists are being encouraged to select gases with lower greenhouse warming potential, optimise the flow of fresh gas and use modern respirators with automated gas functions.

"The objective of this initiative is to make the operation of the operating room sustainable, while integrating a reflection on its economic, social and environmental impact," Dr Pauchard said.

Other theatre initiatives include recycling intravenous plastic tubing and using reusable containers in sterilisation processes.

En cours / à venir..

Recommandation de Pratiques Professionnelles pour la « Réduction de l'impact environnemental de l'anesthésie générale »

SFAR

Comité Développement Durable -SFAR-

SF2H Risque infectieux et soins

SFPC Société française de pharmacie clinique


Merci