Anesthesia Gas Reduction Strategies: Reducing Costs and Environmental Impacts

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I have no disclosures

Climate change is happening

Health is affected by climate change now

Healthcare is contributing to GHG and waste

Volatile anesthetics are potent greenhouses gases

Anesthesia providers have a role and can help

Climate Change, Health and Healthcare

The Environmental Footprint of Anesthesia. *Anesthesiology.* December 2021

Healthcare and Surgical Impacts on Climate Change

- US Healthcare is responsible for 10% of US's GHG emissions (1) and 27% of world's healthcare GHG emissions
- If the US healthcare sector was a country, it would rank 13th in the world (2)
- ORs produce 25-30% of total hospital waste (3)
- One routine surgery produces as much garbage as a family of 4 in one week (4)

1. WRI CAIT 2.0 http://cait2.wri.org
2. Eckelman MJ and Sherman J. PLOS 2/9/16
3. ASA Greening the Operating Room and Perioperative Arena Guidelines
4. Esaki RK e and Macario A. Medscape Anesthesiology 10/21/09

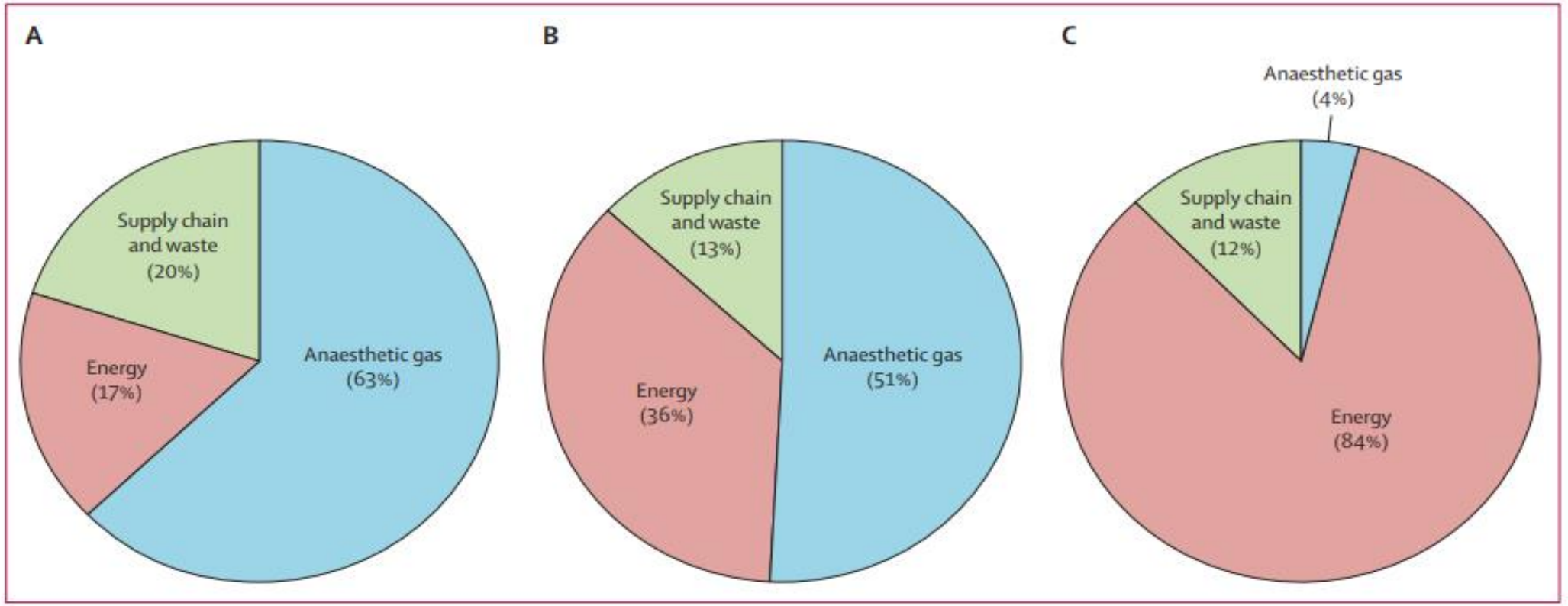


Figure 2: **Relative contribution of scopes 1, 2, and 3 to the carbon footprint of operating theatres at (A) Vancouver General Hospital, (B) University of Minnesota Medical Center, and (C) John Radcliffe Hospital**

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

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 Public Health, 2017

Inhaled Volatile Anesthetic Agents

100ml
10 bottles = $ x

189 miles

250ml
2 bottles = $ x

123 miles

240ml
$ x

2216 miles

Anesthesia Gases

1 MAC inhaled agent at various FGFs	Atmospheric lifetime (yrs)	100 yr Global Warming Potential (GWP) per kg compared to CO2 = 1	Equivalent auto miles driven per hr use of anesthetic
Sevoflurane 2% 2L FGF	1.1	130	8
Isoflurane 1.2% 2L FGF	3.2	510	18
Isoflurane 1.2% 1L FGF			9
Desflurane 6% 2 L FGF	14	2540	400
Desflurane 6% 1 L FGF			200
N2O 60% 1 L FGF	114	298	61

Studies show propofol waste is more than given frequently

Waste appropriately; harmful for aquatic species

ASA Environmental Task Force Guidelines
Sulbaek Andersen MP et al. Anesth Analg 2012; 114(5): 1081-5
Ryan SM and Nielsen CJ. Anesth Analg 2010; 111(1): 92-98
Sherman J et al. Anesth Analg 2012; 114(5): 1086-90

Propofol significantly less GHG emissions than desflurane; even with waste, tubing, electricity for pumps.

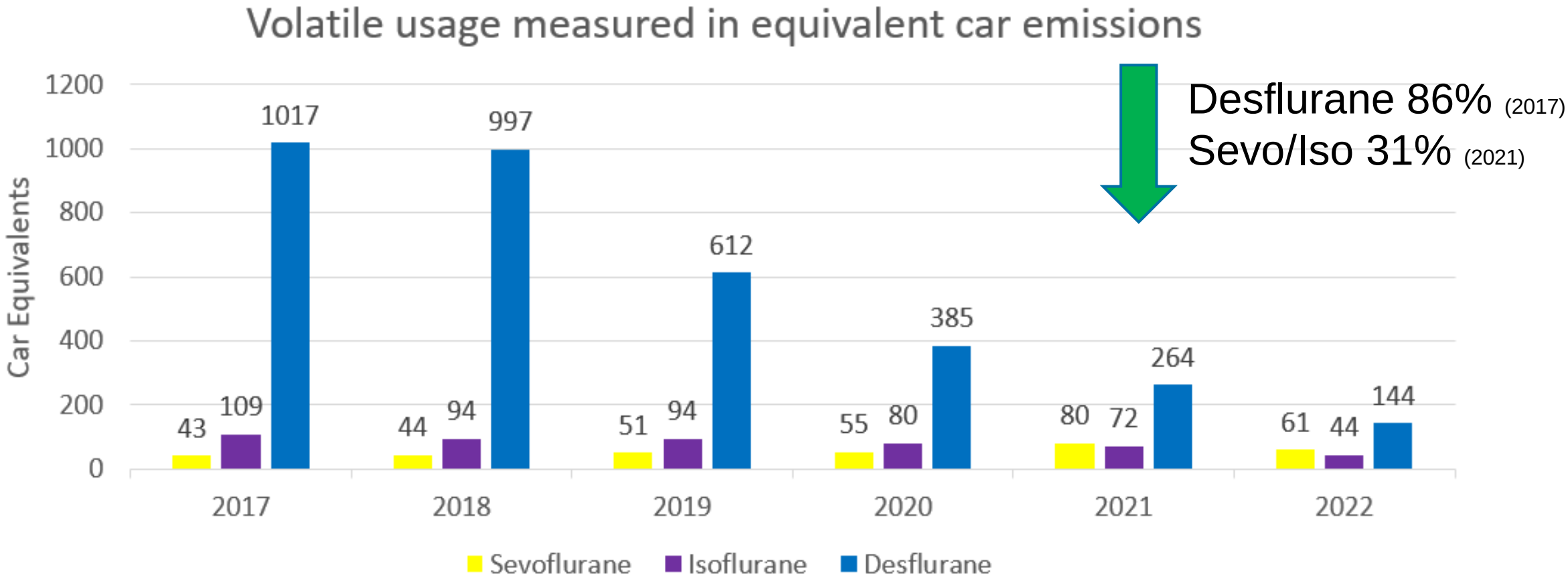
Fresh Gas Flow Examples

Examples


15
9
3
2
1
Fi 25
ml/h
200
20
4
0
CO2 40
0
Gases %
Et
O2 21
O2 Total
0.85
Sev
12
Fi25 O2 flow
0.26
Fresh Gas: O2+Air
O2
85
%
Total Flow
1.00
l/min
Sev
3.4
%


9
3
2
1
Fi 25
ml/h
200
20
0
CO2 40
0
Gases %
Et
O2 21
O2 Total
0.42
Sev
6
Fi25 O2 flow
0.24
Fresh Gas: O2+Air
O2
85
%
Total Flow
0.50
l/min
Sev
3.4
%

MAYO CLINIC ROCHESTER EXPERIENCE



Environmental Impacts of Nitrous Oxide

Global Warming Potential (GWP_{100})

265-273

Lasts **114 years** in the atmosphere

Low potency, high MAC 105%

60% N_2O at 1 L/min FGF

= 60 miles driven in a car

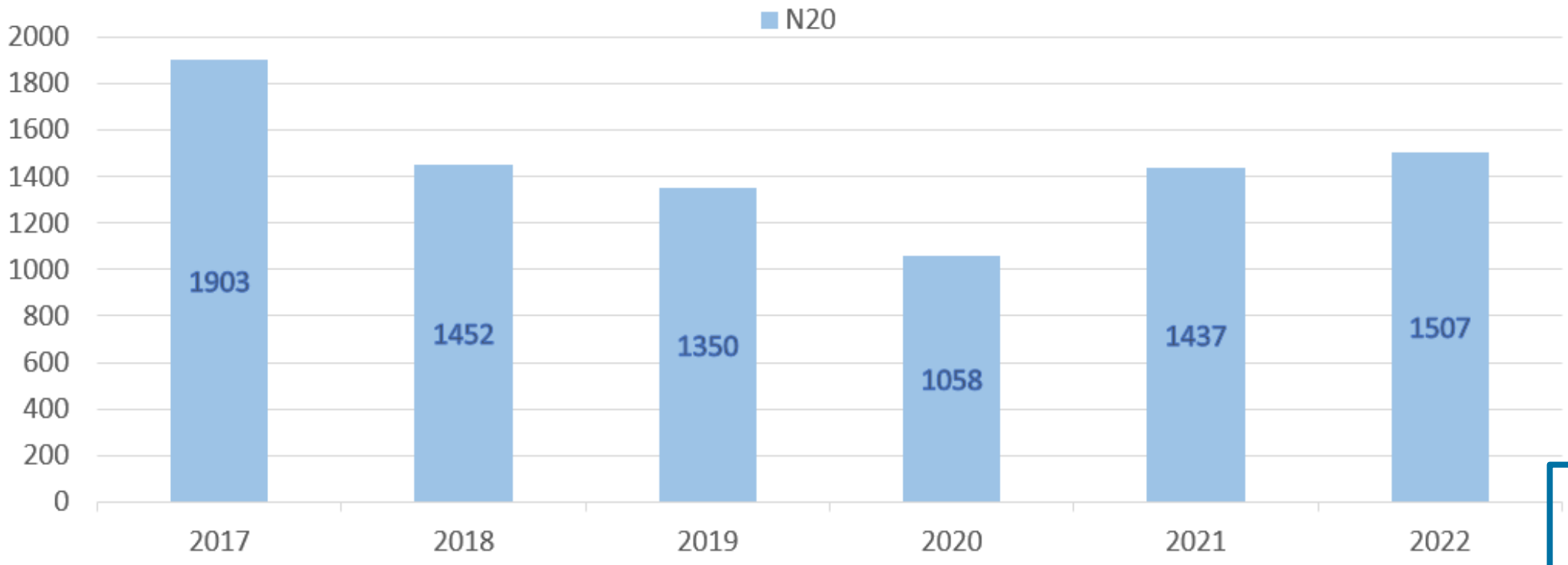
Ozone destroyer

7% of US's GHG
(most agricultural/soil)

- Medical N_2O is significant

ASA Greening the OR toolkit
https://www.epa.gov/ghgemissions/overview-greenhouse-gases

NITROUS OXIDE—6X MORE EMISSIONS THAN OTHER VOLATILE AGENTS, IN 2022



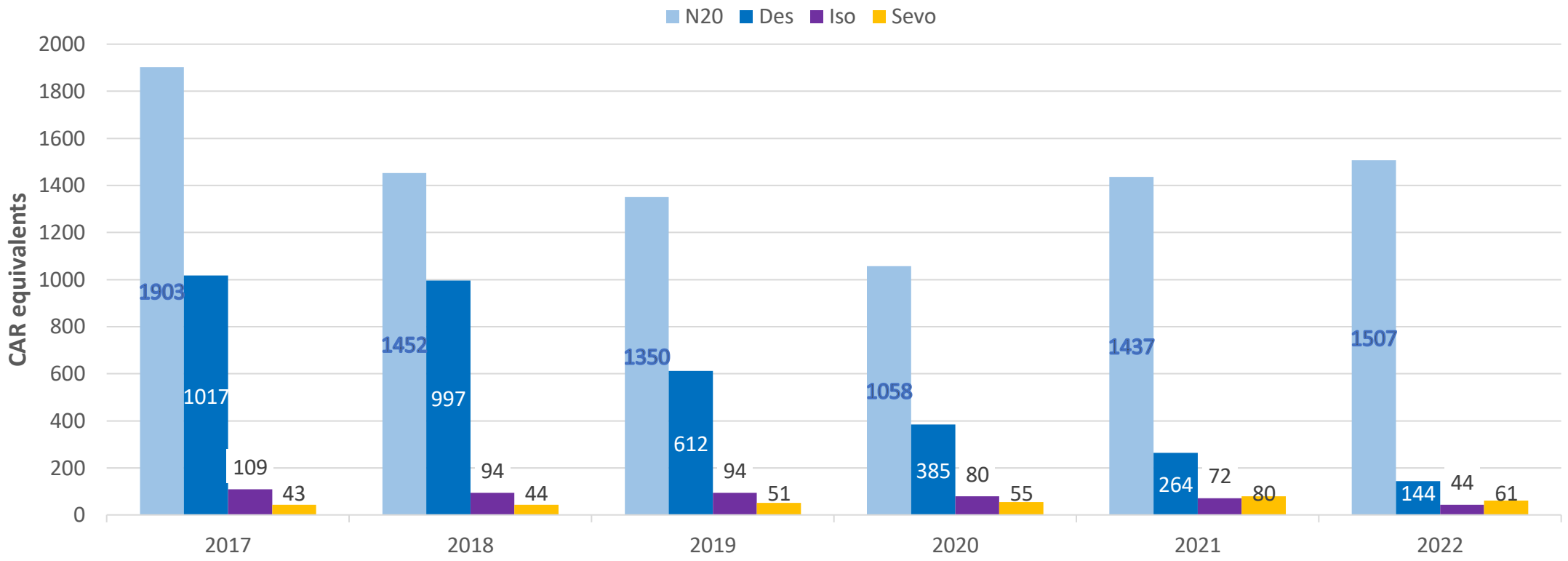
US car: 22 mpg for 1 year or 12,000 miles/yr

Emissions

N20 87%
Des + nitrous 94%

N_2O Impact is 6x Worse than all VAs combined in 2022: Mayo

emissions measured in car equivalents



US car:
22 mpg
for 1 year
or 12,000
miles/yr

GHGs from: Mayo data; epa CO_2 calculator

Des + N_2O %	95%	95%	93%	92%	92%	94%
N_2O alone	62%	56%	64%	68%	78%	87%

Centralized Nitrous Oxide Storage/Transfer: Why it Matters

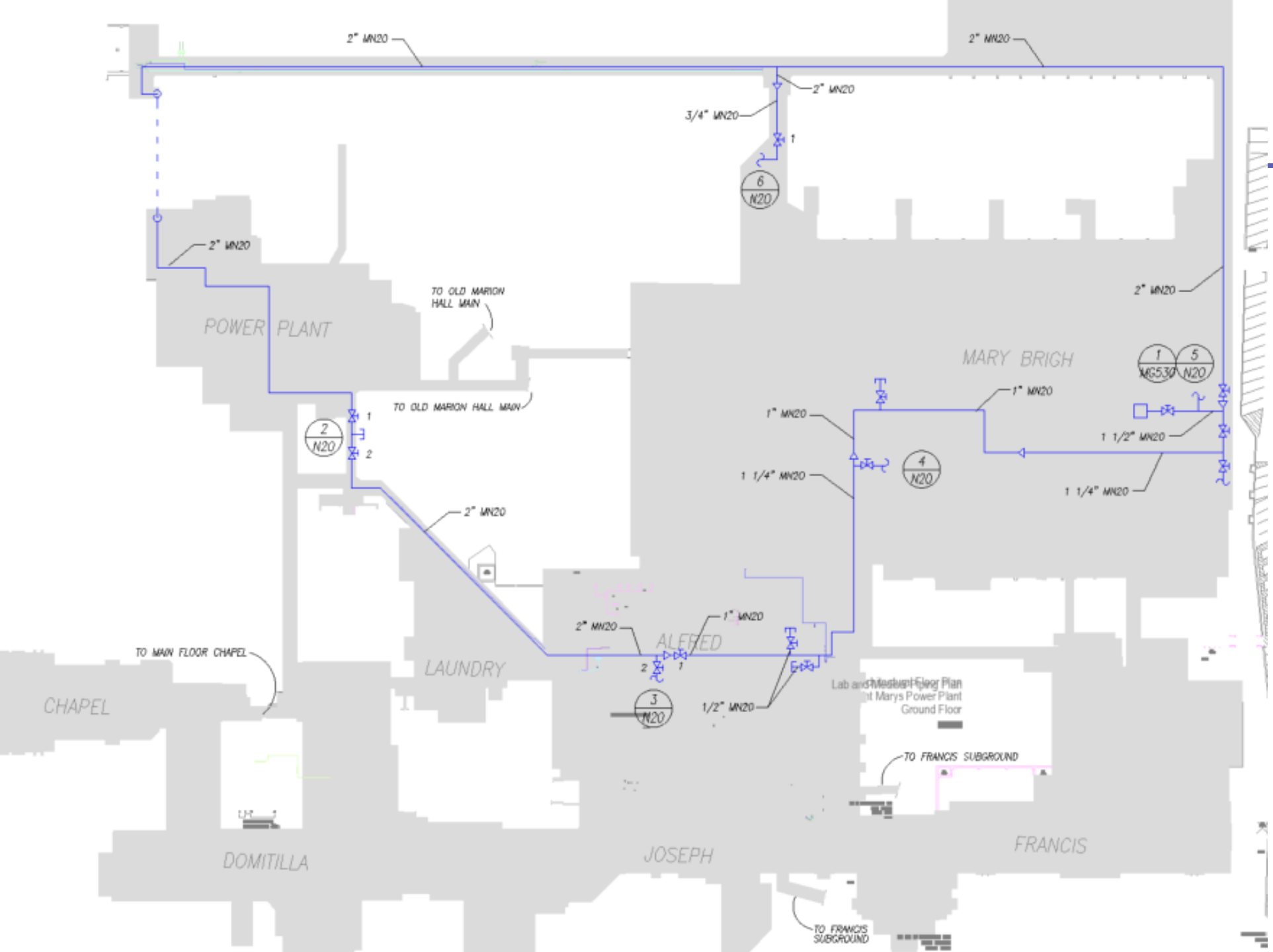
Cryogenic liquid nitrous oxide dewar (380#)

Continuous LEAK in L/min

Compressed gas H cylinder (50#)

Leaks from pipes/connections

Portland Experience, Dr. Brian Chesebro, CleanMed 2022 conference.



St. Marys Hospital
Rochester, MN

1200 beds
9 Buildings

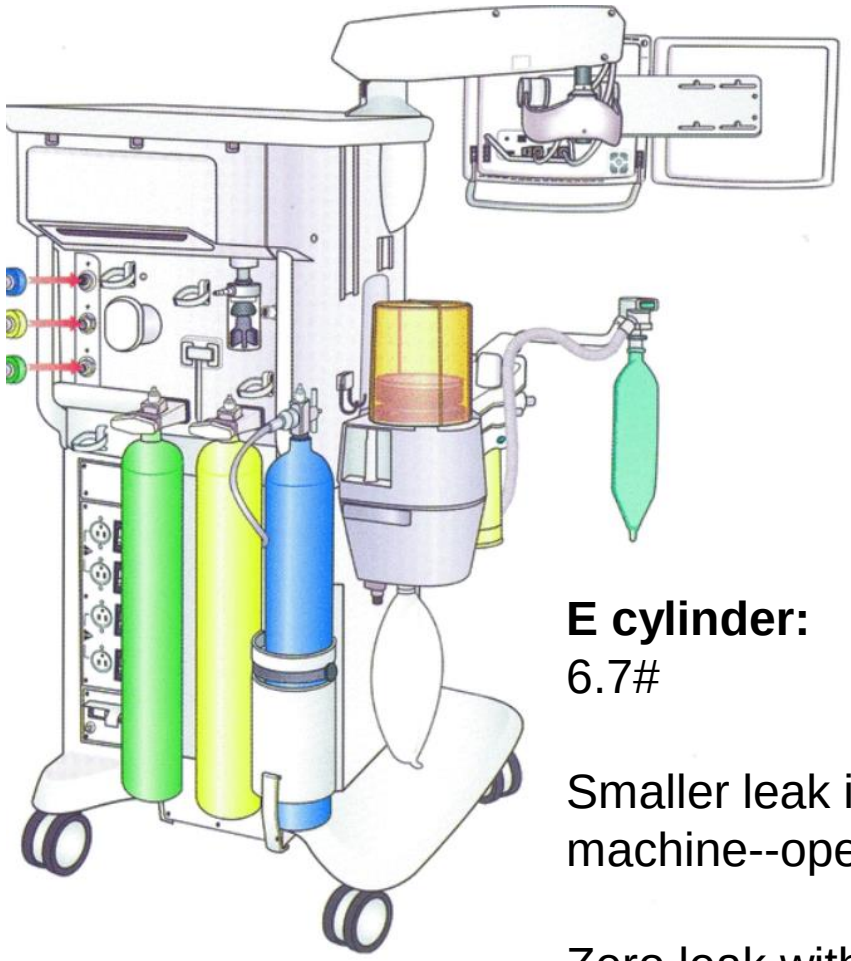
82 ORs
30 outfield

N_2O piping—5 buildings

Engineer—2+ hrs walking

Potential leaks at **every** connection point

Nitrous Procurement Varies by Storage Tank



E cylinder:
6.7#

Smaller leak in mls/min/ machine--open valve

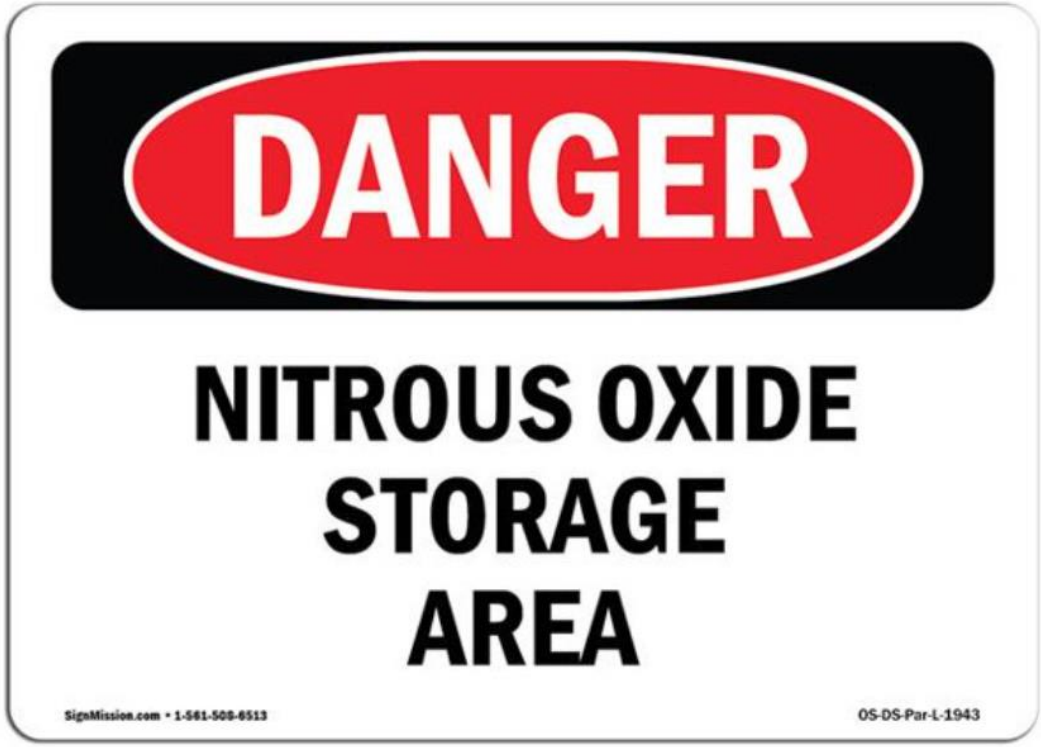
Zero leak with valve closed

	Portland St. Vincent's Hospital mtCO2e	Equiv. Cars	Mayo Rochester mtCO2e	Equiv. Cars
Cryogenic	594	128	6610	1507
Compressed H tanks	234	50		
E cylinders	5.6	1.2	?	15?

- 99% reduction in nitrous oxide procurement
- Recent studies show 90-95% waste

Actions:

- **Centralized nitrous oxide tanks should be decommissioned.**
- E cylinders used at the POC & turned off when not in use.
- Highly selective usage, if at all
- Low flows



Strategies to Reduce Greenhouse Gas Emissions from Laparoscopic Surgery

Thiel C et al. American Journal of Public Health 2018; 108: S158-164.

- Combination of approaches is most effective

Intervention	GHG gas reduction
Maximized recycling, minimized regulated medical waste, reusable gowns and drapes	5%
Using SUD reprocessed instruments	10%
Anesthesia: Avoiding N20, desflurane	25-50%*
Minimizing material use and selecting reusable surgical instruments	50-70%
Occupancy sensors to decrease air exchanges when empty	30% less electricity use—cost savings and GHG reductions

Conclusions

- Think about desflurane and nitrous oxide
  - Selectively use
  - Avoid if you can
  - Decommission or abandon central tanks of nitrous oxide
- Low FGF during maintenance
  - Low flow functions on new anesthesia machines
- Consider propofol supplementation/TIVA
- Consider regional techniques

Thank You

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