Sustainability Workgroup

April 28, 2025
1000 am - 1100 am Eastern Time

Agenda

Introductions and goals for the meeting

Measures to discuss:

- SUS-01: Fresh Gas Flow, less than or equal to 3 L/min
- SUS-04: Fresh Gas Flow, less than or equal to 2 L/min
- SUS-02: Global Warming Footprint, Maintenance
- SUS-05-Peds: Nitrous Avoided, Induction

Measures for next meeting:

SUS-03: Global Warming Footprint, Induction
SUS-06-Peds: Low Fresh Gas Flow, Pediatric Induction
SUS-07: Nitrous Oxide Avoided

Modify measures

- Identify areas identified by the coordinating center to modify measures
- Identify opportunities identified by workgroup to modify measures

Review Literature Updates

Summary and next steps

MPOG

Sustainability Workgroup Members

Name	Institution
Brady Still, MD	UChicago
Seema Gandhi, MD	UCSF
Ben Stam, MD	Corewell West & UM West
Eva Lu Boettcher, MD	University of Wisconsin
Katie O'Conor, MD, MBA	Johns Hopkins
Nick Dalesio, MD	Johns Hopkins
Lucy Everett, MD	Mass General
Liz Hansen, MD	Seattle Children's
Jonathan Paul, D.O.	Columbia University
Jodi Sherman, MD	Yale

Measure Review: SUS-01

SUS-01: Fresh Gas Flow, less than or equal to 3 L/min

Description: Percentage of cases with mean fresh gas flow (FGF) equal to, or less than 3L/min, during administration of halogenated hydrocarbons and/or nitrous oxide.

Threshold: 90%

Exclusions:

- Cases without an ETT or LMA placed
- Cases without halogenated hydrocarbons or nitrous oxide administration
- Cases with < 30 minutes of halogenated hydrocarbons and/or nitrous oxide administered between intubation and extubation
- Cases with documentation of Nitric Oxide use
- Cases with only manually documented fresh gas flow values (fresh gas flow values must be automated to be considered for this measure)

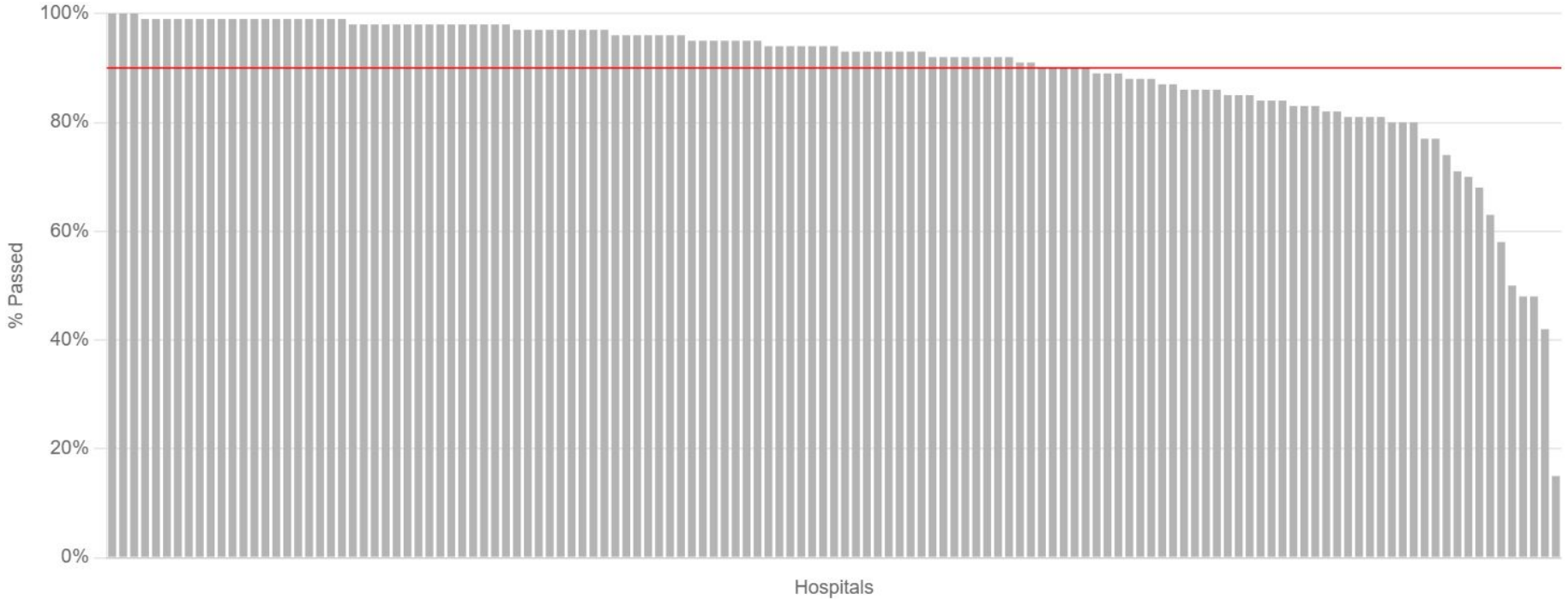
Success: Mean FGF equal to, or less than 3 L/min when inspired halogenated hydrocarbons is > 0.2% or nitrous oxide FGF > 0.2 L/min, during the maintenance period of anesthesia

SUS-01: Fresh Gas Flow, less than or equal to 3 L/min

Other Measure Details:

- If Fresh Gas Flow Total (Concept ID:3214) is documented for the case, this concept will be used to determine success of halogenated agents or nitrous oxide use
- If Fresh Gas Flow Total (Concept ID:3214) is **not** documented for the case, MPOG will calculate Fresh Gas Flow: Flows Oxygen (ID:3215) + Flows Air (ID:3220) + Flows Nitrous Oxide (ID:3225)

Current SUS-01 Performance, All MPOG Institutions, April 2024 - March 2025



Performance: 15% - 100%

Measure Review: SUS-04

SUS-04: Fresh Gas Flow, less than or equal to 2 L/min

Description: Percentage of cases with mean fresh gas flow (FGF) equal to, or less than 2L/min, during administration of halogenated hydrocarbons and/or nitrous oxide.

Threshold: 90%

Exclusions:

- Cases without an ETT or LMA placed
- Cases without halogenated hydrocarbons or nitrous oxide administration
- Cases with < 30 minutes of halogenated hydrocarbons and/or nitrous oxide administered between intubation and extubation
- Cases with documentation of Nitric Oxide use
- Cases with only manually documented fresh gas flow values (fresh gas flow values must be automated to be considered for this measure)

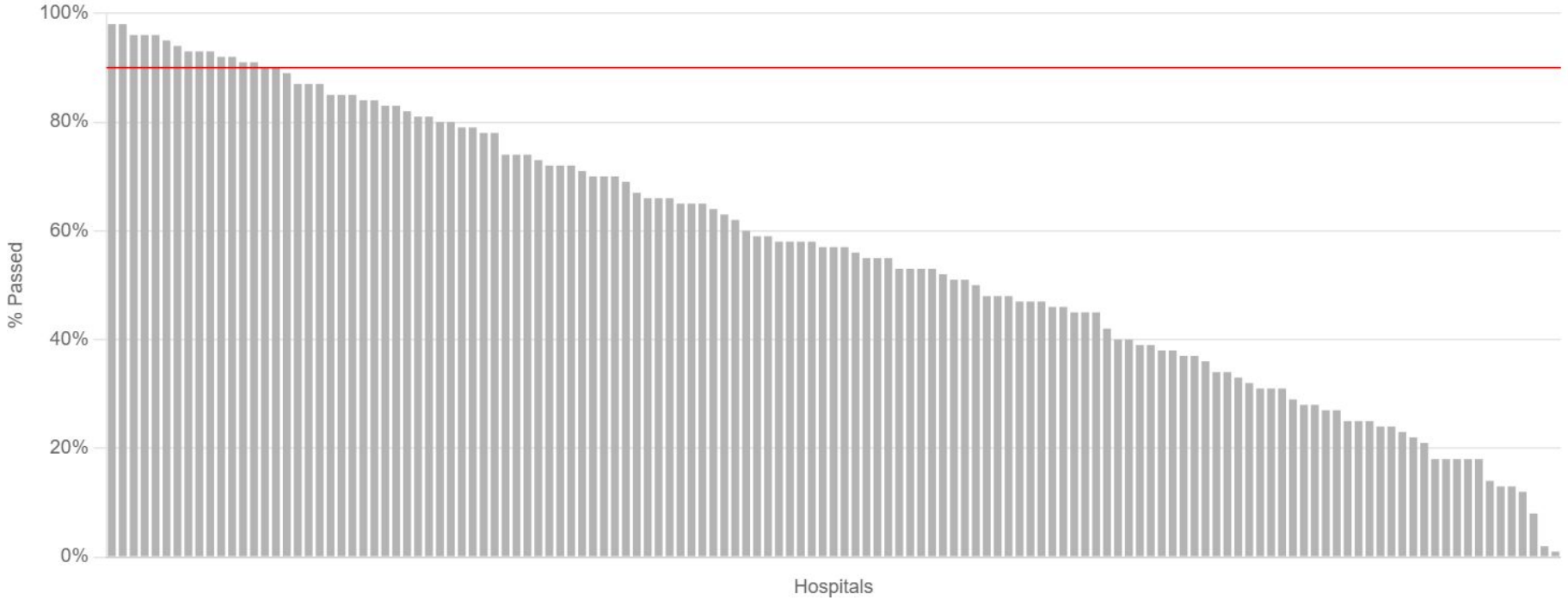
Success: Mean FGF equal to, or less than 2 L/min when inspired halogenated hydrocarbons is > 0.2% or nitrous oxide FGF > 0.2 L/min, during the maintenance period of anesthesia

SUS-04: Fresh Gas Flow, less than or equal to 2 L/min

Other Measure Details:

- If Fresh Gas Flow Total (Concept ID:3214) is documented for the case, this concept will be used to determine success of halogenated agents or nitrous oxide use
- If Fresh Gas Flow Total (Concept ID:3214) is not documented for the case, MPOG will calculate Fresh Gas Flow: Flows Oxygen (ID:3215) + Flows Air (ID:3220) + Flows Nitrous Oxide (ID:3225)

Current SUS-04 Performance, All MPOG Institutions, April 2024 - March 2025



Performance: 1% - 98%

Measure Review: SUS-02

SUS-02: Global Warming Footprint, Maintenance

Description: This measure analyzes the percentage of cases where carbon dioxide equivalents (CO_2 eq) normalized by hour for case receiving inhalational anesthetic agents (desflurane, isoflurane, or nitrous oxide) is less than CO_2 eq of 2% sevoflurane at 2L FGF = 2.83 kg CO_2/hr or the total CO_2 eq is less than 2.83 kg CO_2 for the maintenance period of anesthesia.

Threshold: 90%

Exclusions:

- Cases without an ETT or LMA placed
- Cases without inhalational agent (desflurane, sevoflurane, isoflurane, or nitrous oxide) administration
- Cases with documentation of Nitric Oxide use
- Cases with only manually documented fresh gas flow values (fresh gas flow values must be automated to be considered for this measure)

SUS-02: Global Warming Footprint, Maintenance

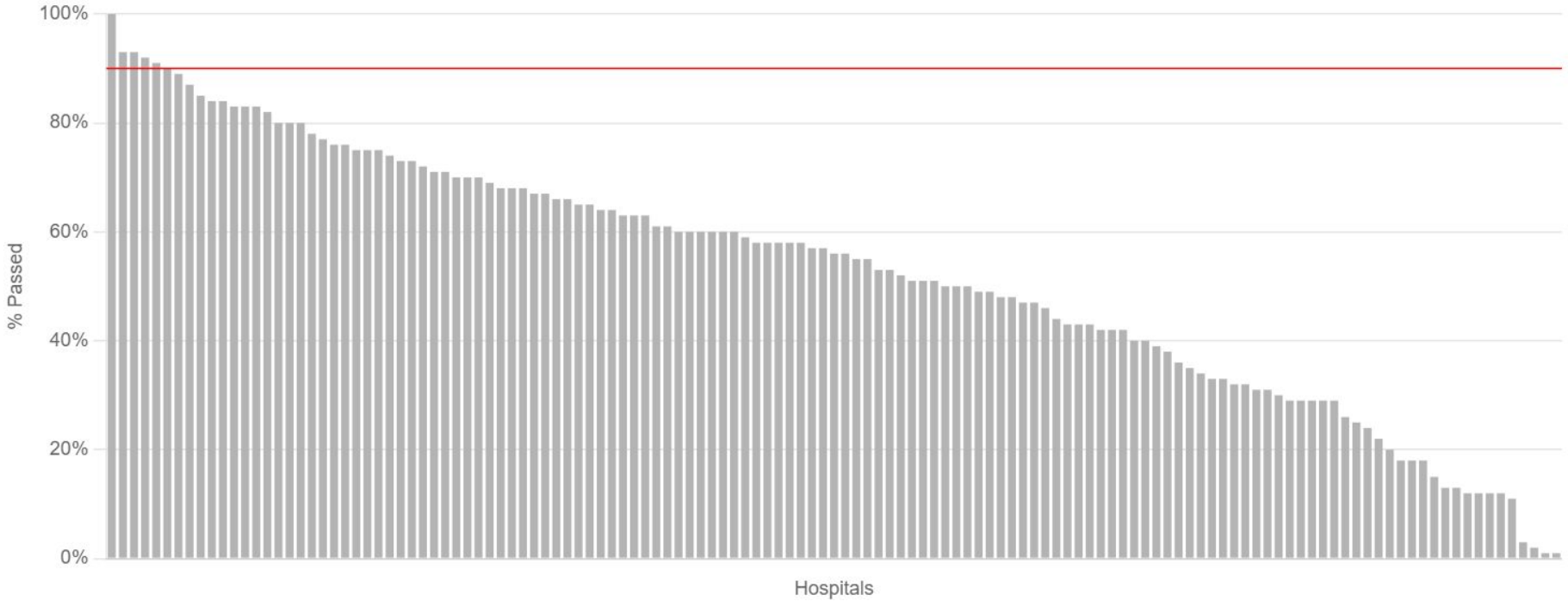
Success: For maintenance phase of anesthesia:

- Mean CO_2 equivalents for a case is < 2.83 kg CO_2/hr. This is equivalent to administering 2% sevoflurane at 2 L/min FGF,
- Total CO_2 equivalents are less than or equal to 2.83 kg/CO_2

Other Measure Details:

- If Fresh Gas Flow Total (Concept ID:3214) is documented for the case, this concept will be used to determine success of halogenated agents or nitrous oxide use
- If Fresh Gas Flow Total (Concept ID:3214) is not documented for the case, MPOG will calculate Fresh Gas Flow: Flows Oxygen (ID:3215) + Flows Air (ID:3220) + Flows Nitrous Oxide (ID:3225)

Current SUS-02 Performance, All MPOG Institutions, April 2024 - March 2025



Performance: 1% - 100%

Measure Review: SUS-05-Peds

SUS-05-Peds: Nitrous Avoided, Induction

Description: Percentage of pediatric patients < 18 years old undergoing general anesthesia where nitrous oxide was avoided during induction.

Threshold: 90%

Exclusions: Age ≥ 18 years

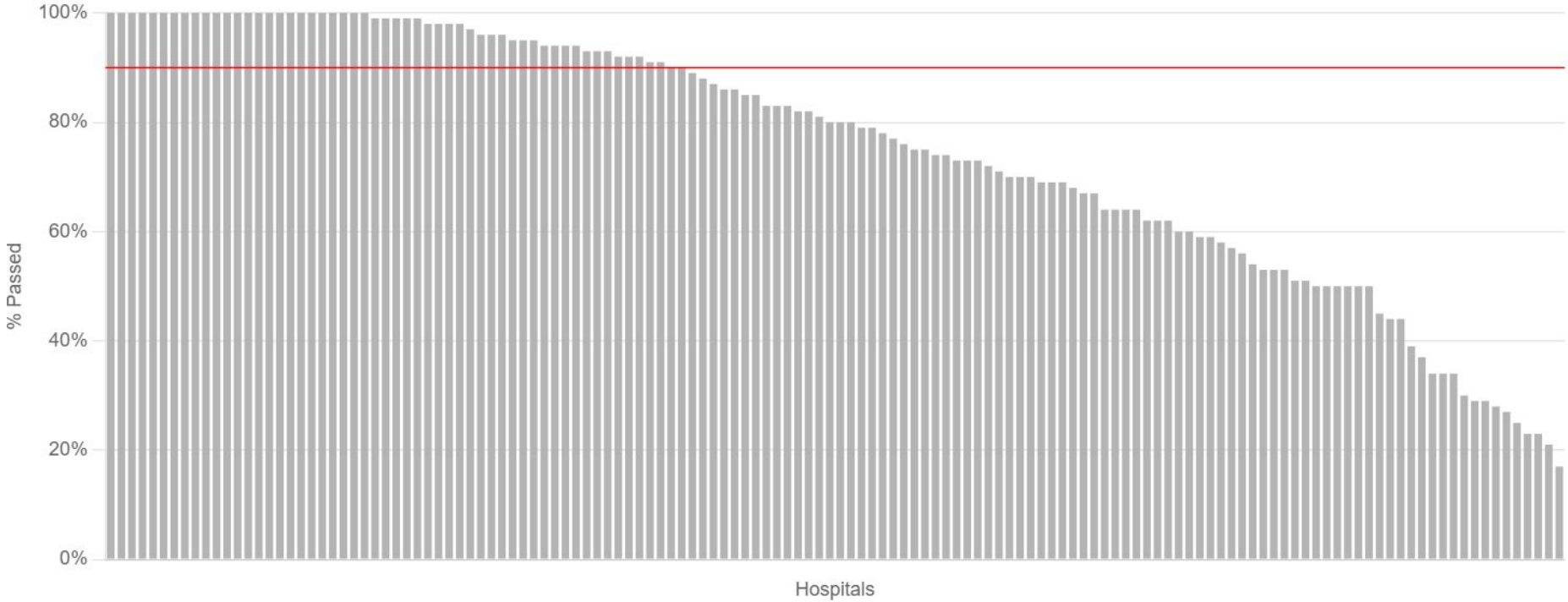
Success: Nitrous oxide was not administered during the induction period of anesthesia

Modifications to Consider: Pass cases with nitrous oxide used during induction AND

1. Flows lower than ____.
2. For less than ____ minutes.
3. Patients < 3y

Rationale: "...can justify avoiding nitrous oxide for pediatric inhalational inductions when preop versed is administered or for patients 2/2.5 years old and younger but would prefer to continue using it for the older children who do not receive preop anxiolytic/amnestic agent"

Current SUS-05-Peds Performance, All MPOG Institutions, April 2024 - March 2025



Performance: 17% - 100%

Feedback we've received

Should MPOG Change kg CO_2 equivalents calculation?

- MPOG currently uses GWP_{100} for kg CO_2 equivalents calculations
- Should we consider using GWP_{20} ?

Global Warming Potential (IPCC report)	
GWP_{20}	GWP_{100}
Desflurane = 7020 *	Desflurane = 2,590 (MPOG uses 2540)
Isoflurane = 1930	Isoflurane = 539 (MPOG uses 565)
Sevoflurane = 702	Sevoflurane = 195 (MPOG uses 144)
Nitrous = 273	Nitrous = 273 (MPOG uses 282)

* 1kg of desflurane has the same effects as 7,020 kg of carbon dioxide over a period of 20 years

GWP Discussion

GWP_{100} significantly underestimate the climate effects in the coming decades. The 20 year time horizon values much better reflect the climatological reality for the next 50 years.

Our GWP values don't currently use the latest GWP values from the IPCC.

All-Inclusive Carbon Footprint of Inhalation Anesthesia

GWP_{100} and GWP_{20} values for all volatile anesthetics can be found in the IPCC report (isoflurane = HCFE-235da2 ; desflurane = HCFE-236ea2 ; sevoflurane = HFE-347mmz1).

Additional background on GWP_{100} and GWP_{20}

The future is now—it's time to rethink the application of the Global Warming Potential to anesthesia

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Additional information…

The science of climate change and the effect of anaesthetic gas emissions

“On the basis of GWP, anaesthetic gases appear to be very 'damaging'. However, this conclusion is scientifically unsound: their lifetimes are short; their emissions, accumulation and resulting atmospheric concentrations are minute; and their actual radiative forcing is vanishingly small."

and.. "A key reason that CO2e values are misleading is that long- and short-lived gases affect atmospheric concentrations, and thus the planet's energy budget, in fundamentally different ways."

…halogenated hydrocarbons such as sevoflurane, desflurane and other inhaled anesthetic vapors are near term climate forcers and hence shorter GWP numbers (GWP-20) needs to be employed while the GWP-100 numbers are better suited for long term climate forcers such as Nitrous Oxide."

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Method to calculate kg CO_2 equivalents

Gold Standard: agent consumption from the anesthesia machine

Current MPOG methodology uses Fresh Gas Flow x Inspired Agent

Cuveele Method: Use FGF, minute ventilation (MV), agent inspired concentration (F_{IN}), agent end-expired concentration (F_{ET})

MPOG Method will generally underestimate use compared to Cuveele.

In a soon to be published analysis, compared to what the machine estimates, Median Absolute Prediction Error (%) was 16% for MPOG and 6% for Cuveele. 90% of the time Cuvelle was within 20% of what the machine estimated, this was only 57% of the time for the MPOG method

Not all sites are able to send MPOG F_{ET} and MV

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Cuveele's method to calculate anesthetic agent

- If both fresh gas flow (FGF) and vaporizer dial setting (dialed F_{VAP}) are available, anesthetic agent consumption can be calculated as a product of FGF and F_{VAP}
- If F_{VAP} is unknown, theoretical model for calculating F_{VAP}, based on FGF, minute ventilation (MV), agent inspired concentration (F_{IN}), agent end-expired concentration (F_{ET}) and dead space ventilation (V_D)
- $F_{VAP} = [F_{IN} - (\text{dead space fraction} * F_{IN} + (1 - \text{dead space fraction}) * F_{ET}) * (1 - FGF/MV)]/(1-(1 - FGF/MV))$
- Dead space fraction for sevoflurane, desflurane, and isoflurane was therefore determined empirically

$$F_{VAP} = \frac{F_{IN} - (\text{dead space fraction} * F_{IN} + (1 - \text{dead space fraction}) * F_{ET}) * \text{fraction of rebreathing}}{(1 - \text{fraction of rebreathing})}$$

$$\text{Amount of vaporized agent (L/min)} = \frac{FGF * (F_{IN} - (\text{dead space fraction} * F_{IN} + (1 - \text{dead space fraction}) * F_{ET}) * \text{fraction of rebreathing})}{(1 - \text{fraction of rebreathing})}$$

Other changes to consider

Should we measure very low FGF (< 1 l/min)?

- SUS-01: Fresh Gas Flow, less than or equal to 3 L/min
- SUS-04: Fresh Gas Flow, less than or equal to 2 L/min
- SUS-08?: Fresh Gas Flow, less than or equal to 1 L/min?

Should we identify short cases with high maintenance flows?

- Some of these cases have < 2.83 kg CO_2
- Would have to choose a value lower than 2.83 kg CO_2 or use some other method to identify these cases
- For example, we could calculate the kg CO_2 per minute instead of per hour

Thank You!