CASCADES

SUSTAINABLE PERIOPERATIVE CARE

Project Charter Summary

MINIMIZE DIRECT EMISSIONS

Low Flow Administration of Anesthetic Gases

PROJECT CHARTER: See the full version of the project charter for more change ideas, details, and a complete list of references.

Inhalational anesthetic agents are potent greenhouse gases with global warming potentials hundreds to thousands of times higher than that of CO_2. Fortunately, the volume of inhalational anesthetic agents used during surgery—and released into the atmosphere—can be decreased by lowering fresh gas flow (FGF).

In the past, low flow anesthesia with sevoflurane (the preferred choice for modern inhalational anesthesia) was controversial because of concerns relating to the production and accumulation of potentially harmful Compound A in the breathing circuit. However, numerous studies have now shown that sevoflurane is safe to use with minimal flows. Low flow anesthesia is common in many jurisdictions and, in addition to environmental benefit, enhances temperature/humidity preservation and cost savings by more efficiently using anesthetic gases.

Minimal flow anesthesia is endorsed by the Canadian Anesthesia Society, which recommends FGF ≤ 1 L/min and ideally 0.5 L/min in their 2023 Revised Guidelines to the Practice of Anesthesia (section 10).

GOAL: Use minimal fresh gas flow for general anesthesia with an inhalational anesthetic agent

PROJECT SCOPE: Operating rooms or perioperative environments where inhalational anesthetics are given

EMISSIONS SCOPE: Scope 1 (direct GHG emissions originating from sources controlled & owned by the organization)

ESTIMATING IMPACT

ACTIVITY/OUTCOME METRIC

- MAC-hours of common anesthetic gases over one month
- Average fresh gas flow and vaporizer settings for each gas

- Can be sourced from pharmacy procurement data, EMR data, or self-audits.
- Monthly counts are recommended to observe progress, but data can be processed for any given time period.

RELATED ENVIRONMENTAL METRIC

kg CO_2e per MAC-hour of anesthetic

Gas	FGF 0.5	FGF 1	FGF 2
Sevo (2%)	0.64 kg CO_2e	1.29 kg CO_2e	2.58 kg CO_2e
Iso (1.2%)	1.39 kg CO_2e	2.79 kg CO_2e	5.57 kg CO_2e
Des (6%)	31.48 kg CO_2e	62.97 kg CO_2e	125.94 kg CO_2e
N_2O (60%)	9.75 kg CO_2e	19.5 kg CO_2e	39 kg CO_2e

Sources:

- Volatile anesthetic values calculated using the Association of Anesthetists' Anesthetic Gases Calculator using published GWP100 values
- N_2O calculated with data from Hanna & Bryson

ENVIRONMENTAL IMPACT

Estimation of total impact in kg CO_2e

- Estimate the kg CO_2e/MAC-hour for all gases.
- There should be a reduction in this number over time as practitioners reduce their fresh gas flows.
- Use the Natural Resources Canada Greenhouse Gas Equivalencies Calculator to translate your results to stakeholders.
- Convert the amount to g CO_2e and divide by 206 g CO_2e/km to obtain the km driving equivalent.

Project Charter developed in collaboration with the Ontario's Anesthesiologists Environmental Sustainability Working Group.
Charter summary developed by Dr. Connor Brenna.

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Root Causes and Change Ideas for Low Flow Administration of Anesthetic Gases

PLAYBOOK:
View the playbook for other perioperative sustainability opportunities and resources.

VIDEO: Sustainable Anesthetic Practices with Dr. Anita Rao & Dr. Peter Menikefs

EDUCATION & AWARENESS

Some anesthesiologists are unaware of the environmental impact of anesthetic gases, and historical concerns regarding Compound A and plasma fluoride linger. Product monographs contain erroneous warnings recommending against low flows (e.g., < 2 L/min).

- Run educational sessions for anesthesiologists and trainees to socialize the importance of addressing environmental sustainability, and emphasize the importance of minimizing FGF.
- Review the CAS Guidelines for Environmental Sustainability with your team.
- Review the financial benefits of conserving anesthetic agent by using low flows.
- Review the literature clearly establishing the safety of low flow anesthesia.

CLINICAL WORKFLOW

Some anesthetic gas machines are automatically programmed to operate at a FGF of 2 L/min by default due to unwarranted concerns about Compound A during the era in which they were engineered.

- Change hospital policy and anesthesiologist practice patterns to habitually select low flow when administering anesthetic gases.
  - Carter et al describe their experience doing this in a UK tertiary hospital.
- Several strategies to safely reduce FGF are offered by the ASA Protocol for a Safe Minimum Fresh Gas Flow Practice;
  - During induction of anesthesia, the desired anesthetic concentration can be achieved by increasing the vaporizer setting rather than the FGF rate.
  - During endotracheal intubation, FGF can be paused rather than turning off the vaporizer.
  - During maintenance of anesthesia, low FGF can be maintained with continuous monitoring of inspired oxygen concentration and exhaled anesthetic vapor concentration.
  - During emergence from anesthesia, the vaporizor can be turned off while a low FGF is maintained, to ensure adequate time for emergence.

FINANCES & PROCUREMENT

Modern anesthetic gas machines have significant upfront costs.

- Negotiate the purchase of anesthetic gas machines that can deliver low or metabolic rates.
- Create a business case with the buy back period and potential cost savings of the modified or new machines given the increased efficiency in anesthetic gas use that they will facilitate.

INFRASTRUCTURE

Some anesthetic gas machines may not be able to deliver <0.5 L/min on auto-control (though they can be set manually). There is a concern that warranties may be voided if machines are otherwise modified by hospitals' medical engineering departments.

- Consult your biomedical engineering department to program automated settings to minimal flows when end-tidal control is enabled.
  - At a Toronto area hospital, the engineering department requested guidance from GE to reprogram their GE Aisys machines, to reduce the default minimum flow with sevoflurane from 2 L/min to 0.5 L/min. Manufacturers like GE recognize the environmental benefits of low FGF; this process was easy, and had no associated costs.

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