North Shore/Long Island Jewish Hospital Anesthesia Department Quality Improvement Initiative to Reduce Volatile Anesthetic Waste in the Operating Room

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Introduction

- Volatile anesthetic agents such as sevoflurane and isoflurane comprise over 5% of hospital related greenhouse gases.
- Emission is dependent on the concentration of volatile gas and the fresh gas flow (FGF) through the airway circuit.
- The FDA has historically recommended higher FGF (>2liters/minute) based on the concern for toxic byproducts of sevoflurane and strong bases in CO2 absorbents including carbon monoxide and Compound A.[1]
- Compound A was previously shown to be nephrotoxic in rat models. However, more recent studies have since demonstrated no evidence of renal toxicity in humans who undergo low FGF sevoflurane.[2,3]
- Societies including the American Society of Anesthesiologists and Anesthesia Patient Safety Foundation have made recommendations in support of low FGF, below 1 liter/minute.
- This project's primary goal is to reduce the excess use of inhaled volatile gas anesthetics in North Shore/LIJ operating rooms through department education.

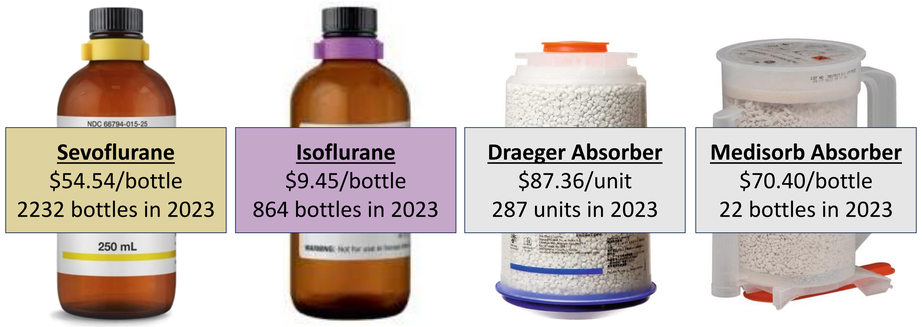
Methods

- The Plan-Do-Study-Act format was used to design and implement this resident quality improvement project.
- Baseline data was established by review of 149 general anesthesia cases representing 48 different providers over the month of June 2023. Ventilator data including total fresh gas flow was obtained and an estimated cost and CO2 emissions analysis was performed.
- For our QI intervention, the anesthesia departments at North Shore and at LIJ were presented this baseline data and educated on the safety and benefits of low fresh gas flow anesthesia. Written material was distributed summarizing this material as well. A soft-alert system was also added to our intraoperative EMR to alert providers when fresh gas flows are running at elevated rates (this will be included in Epic).
- Follow up data was obtained one month after the initial intervention.

Results

Pre-Intervention Fresh Gas Flows

Gas	n	Average	St. Deviation	Range
Sevoflurane	128	2.46	1.37	0.62-10
Isoflurane	21	2.65	1.49	0.95-7.06
Total	149	2.49	1.40	0.62-10



Sevoflurane
$54.54/bottle
2232 bottles in 2023

Isoflurane
$9.45/bottle
864 bottles in 2023

Draeger Absorber
$87.36/unit
287 units in 2023

Medisorb Absorber
$70.40/bottle
22 bottles in 2023

Post-Intervention Fresh Gas Flows*

Gas	n	Average	St. Deviation	Range
Sevoflurane	91	1.84	0.51	0.89-3.66
Isoflurane	5	1.67	0.32	1.28-2
Total	96	1.83	0.50	0.89-3.66

*Preliminary data based on ongoing incomplete post-intervention data collection.

Discussion

- Pre-intervention data demonstrated an average FGF of 2.49L/min with wide inter-provider variability (0.62-10L/min).
- Our providers preferentially utilized sevoflurane, with no providers utilizing nitrous oxide as a maintenance agent.
- The total cost of volatile gas anesthetics for NSUH in 2023 was $129,898.08.
- Preliminary post-intervention data demonstrated an average total FGF of 1.83L/min. This represents a 26.5% total reduction from pre-intervention with a 25.2% reduction in sevoflurane and 37.0% reduction in isoflurane.
- Assuming equal case volume and continued use of lower FGF levels, this intervention could save the NSUH department $33,697.77 on anesthetic gases annually.
- Assuming one 250mL bottle of sevoflurane consumption during anesthesia is equivalent to driving 125 miles and one 100mL bottle of isoflurane is equivalent to driving 194 miles, over the course a year this intervention at its current stage saves the environment from the CO2 equivalent of 132,326 miles of driving from a standard passenger car. [4,5]
- While our providers have responded well thus far to the intervention, recent studies have shown using agents such as sevoflurane are safe at even FGF <1L/min, meaning we have room to continue to improve.
- Both the environmental impact and financial benefits of low FGF can be amplified if this initiative were to roll out system wide.

References

1. Abbvie Ltd. Ultane (sevoflurane) package insert. https://www.accessdata.fda.gov/drugsatfda_docs/label/2006/020478s016lbl.pdf. Published 2003. Accessed Feb 18, 2024.

2. Feldman JM, Hendrickx J, Kennedy RR. Carbon Dioxide Absorption during Inhalation Anesthesia: A Modern Practice. Anesth Analg. 2021;132(4):993-1002. doi:10.1213/ANE.0000000000005137

3. Sondekoppam R V., Narsingani KH, Schimmel TA, McConnell BM, Buro K, Özelsel TJP. The impact of sevoflurane anesthesia on postoperative renal function: a systematic review and meta-analysis of randomized-controlled trials. Can J Anesth. 2020;67(11):1595-1623. doi:10.1007/s12630-020-01791-5

4. Campbell M., Pierece JM. Atmospheric science, anaesthesia, and the environment. BJA Education. 2015;15(4):173-179. doi: 10.1093/bjaceaccp/mku033

5. EPA . Greenhouse gas Equivalencies calculator. Washington, DC: United States Environmental Protection Agency, 2021. https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator