UNIVERSITY OF CALIFORNIA **Carbon Neutrality Initiative**

UCSF

Economic and environmental impact of optimizing fresh gas flow use with inhaled anesthetics

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UC Carbon Neutrality Initiative

Climate change is real and 2015 was the warmest year on record. The Carbon Neutrality Initiative builds on UC's pioneering work on climate research and furthers the efforts to improve energy efficiency, develop new sources of renewable energy, and execute strategies to cut carbon emissions. By 2025, UC is committed to emitting net zero greenhouse gases. As as the healthcare sector represents 8% of all US carbon emission, the role of medical centers should not be overlooked.

Introduction

Potent inhaled anesthetics and nitrous oxide are environmentally deleterious greenhouse gases (GHGs) used routinely in the practice of anesthesia. These agents are minimally metabolized and thus end up in the atmosphere. Accumulation of these gases can be detected even in pristine, remote, Antarctic air.

	Global Warming Potentials (100 year time horizon)		
	Isoflurane	Desflurane	Sevoflurane
Sulbaek Andersen (2012)	510	2540	130

The use of desflurane for 1 hour results in the equivalent GHG effect of driving 200 to 400 miles compared with 18 and 20-40 miles of driving per 1 hour of use of sevoflurane and isoflurane, respectively. A busy midsize hospital might purchase >1000 L of inhaled anesthetics per year which according to Ryan and Nielsen would be the equivalent of 100-1200 passenger car emissions/year/midsize hospital depending on which inhaled agent is utilized. Fresh gas flow (FGF) dictates how much agent is released into the environment.

Materials and Methods

Mean FGF and volume volatile agent utilized per case was first captured from the ventilator and incorporated into the electronic medical record (EMR). In March 2015, we began data collection on FGFs utilized in the UCSF operating rooms. The initial audit period was not advertised and the data collection was sufficiently discrete as to not alert anesthesia providers.

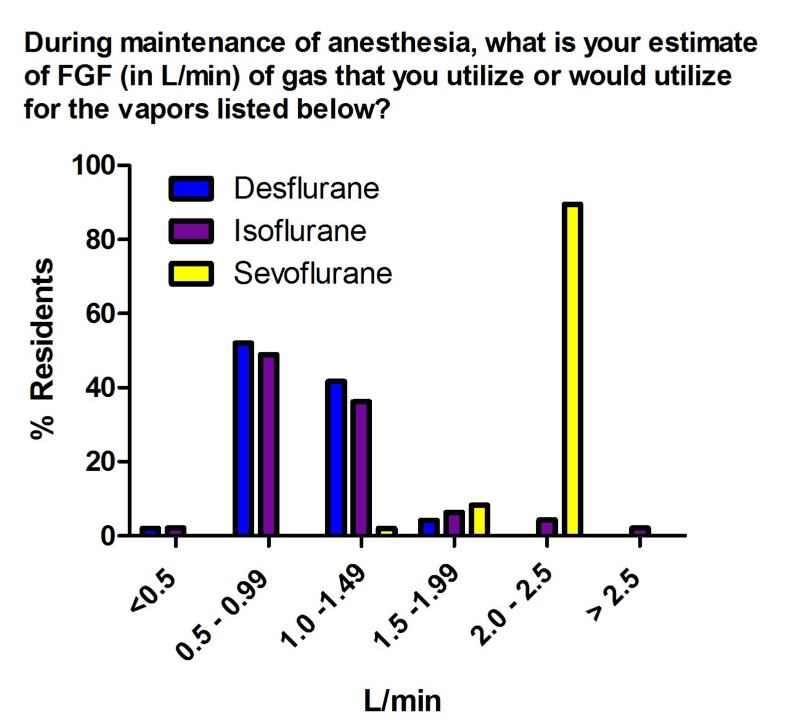
Cases greater than 2 hours were included due to large variability in FGFs utilized for the induction of anesthesia and emergence from anesthesia. Cases performed outside of the OR (MRI, CT scanner, and other remote locations) were not evaluated.

A multiple choice survey was sent to all UCSF anesthesia residents (CA-1 - 3) during the initial data collection (N= 73). Forty-eight residents (65%) responded to the survey.

Providers were educated in grand rounds, flyers were placed on anesthesia machines, reminder text pages and e-mails were sent to anesthesia providers. Data was exported from EPIC (Epic Systems) and analysis was performed using Prism (GraphPad Software) and Excel (Microsoft). Descriptive statistics were used to summarize the data.

Results

A



B

Most environmentally friendly agent (% answered)	Total	CA-1 (n=20)	CA-2 (n=10)	CA-3 (n=14)
Desflurane	0	0	0	0
Isoflurane	19	15	30	21
N_2O	54	45	70	50
Sevoflurane	27	45	0	29

Least environmentally friendly agent (% answered)	Total	CA-1 (n=20)	CA-2 (n=10)	CA-3 (n=14)
Desflurane	75	75	80	71
Isoflurane	10	15	10	0
N_2O	6	0	0	21
Sevoflurane	8	10	10	7

Figure 1. A. Practice patterns assessed via survey. **B.** Provider knowledge based on a multiple choice survey. Twenty-seven percent of respondents identified the most environmentally friendly agent (sevoflurane), while 75% of residents correctly identified the least friendly agent (desflurane). The majority of residents (> 90%) successfully identified the most and least expensive agents (desflurane and isoflurane, respectively). Only 10% of respondents described themselves as both environmentally and cost-conscious when planning their anesthetic. 48% of respondents were aware of a "Pause Gas Flow" option on the Aisys anesthesia machine.

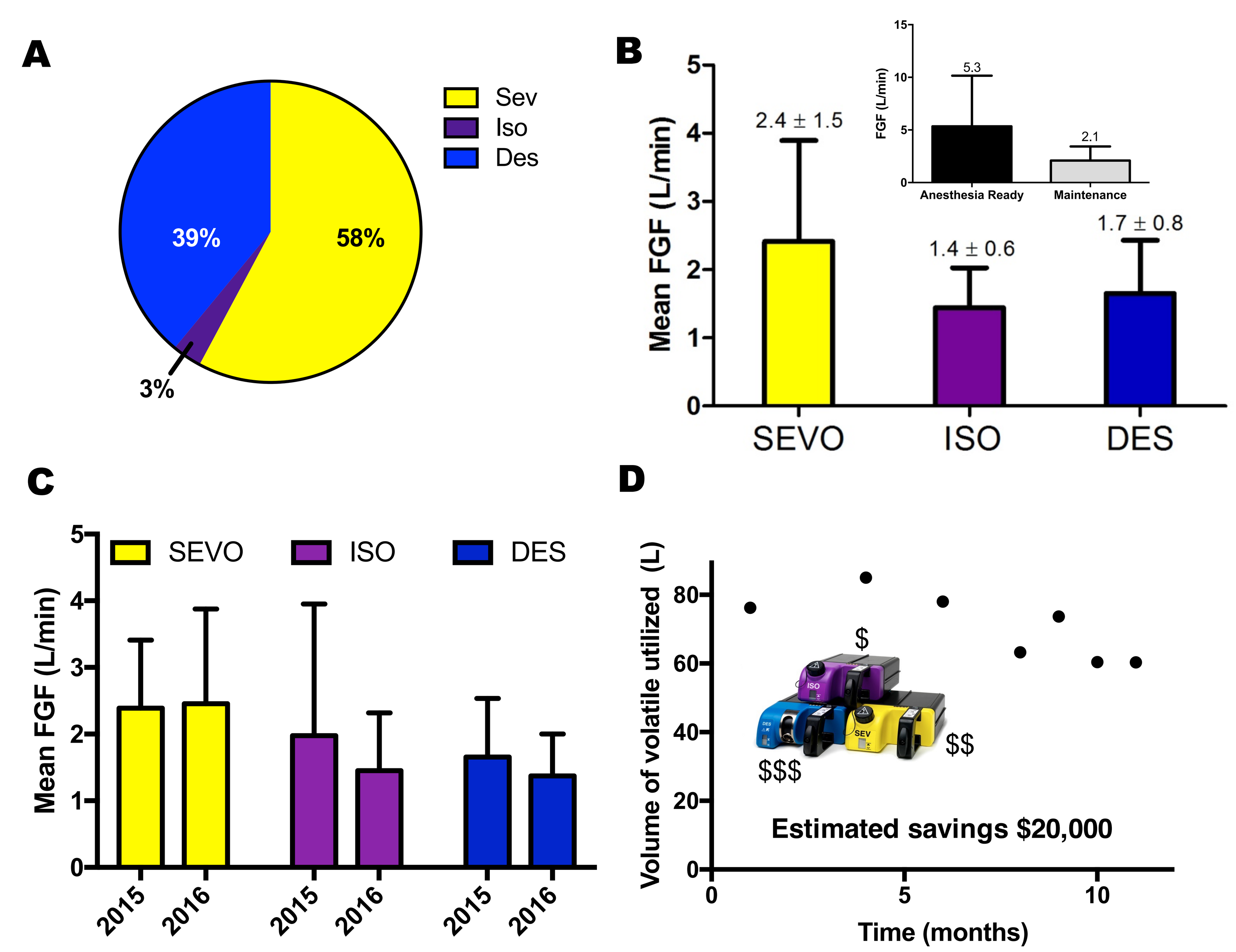


Figure 2. A. Volatile agent usage/ preference among all providers assessed over 3 months. **B.** Mean FGFs and standard deviation (SD) during the audit period when providers were not aware that FGFs were being recorded. (inset) Mean FGFs and standard deviation (SD) at anesthesia ready (early in the case, prior to the initiation of surgery) vs. the maintenance of anesthesia (middle of the surgery). **C.** Comparison of mean FGFs for all providers in April 2015 and 2016 during the maintenance of anesthesia. **D.** Sum of monthly mLs volatile anesthetics during the study period.

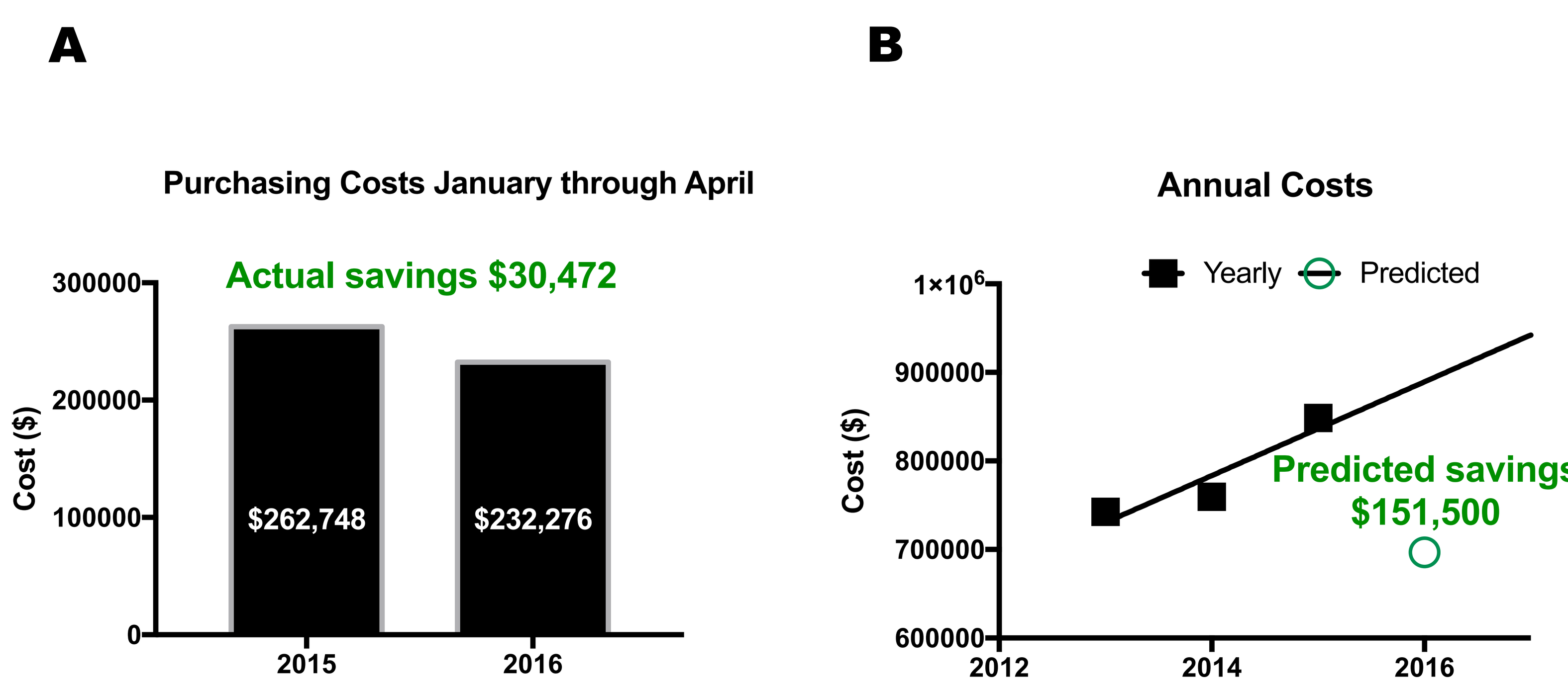


Figure 3. A. Purchasing costs for all volatile agents during the months of January – April during the 2015 and 2016 fiscal year. Data during 2015 reflects spending prior to the initiation of this project, whereas 2016 reflects spending after then project was announced. **B.** Annual costs of all volatile agents from 2013-2015 (black squares). Line reflects best fit line of the data over 3 years. Predicted annual costs for 2016 were estimated based on actual spending during the first four months of 2016 (January – April). Predicted savings were calculated in comparison to actual spending in 2015.

Future Directions

- Continued education of anesthesia providers to make low flow anesthesia the norm
- Incentives for low usage
- Personalized feedback on FGFs
- Advocacy regarding environmental harm within anesthesia societies
- Evaluate the use of nitrous oxide by anesthesia providers

Low flow anesthesia (FGFs of 1 L/min or less) during the duration of this project saved approximately $30,000, with estimated annual savings of $151,500.

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Acknowledgments

David Robinowitz and Jon Spinner for technical help in the EMR and generating reports for data analysis. Susan Ryan as a faculty member who inspired this project and Jim Sonner for assistance with cost and excess gas calculations. Project funded by University of California Presidential Carbon Neutrality Initiative Fellowship Program.

www.ucop.edu/initiatives/carbon-neutrality-initiative.html