A Pragmatic Multi-Component Initiative to Reduce Anesthetic Gas Emissions: An Ongoing Institutional Case Study from a LMIC

Samie Asghar Dogar FCPS, MPH. Muhammad Sohaib FCPS, Ausaf Khan FCPS, Waleed Bin Ghaffar FCPS, Asad Latif, MD, MPH
The Aga Khan University Hospital, Karachi, Pakistan

Introduction

•Healthcare = 4–5% global GHG emissions; anaesthetic gases disproportionately high.
•At AKUH Karachi, carbon audit showed 6% of hospital emissions from anaesthetic gases.
•LMICs: resource-constrained ⟶ need low-cost, pragmatic sustainability models.
•Technology alone is insufficient (ETC); clinician behaviour & system redesign are key levers.

Purpose

•Purpose: Design and evaluate a multi-component framework to reduce anaesthetic gas emissions and costs.
•Hypothesis: Combining judicious technology use (ETC, monitoring) with behavioural change (low flows, nitrous avoidance) will achieve measurable reductions, scalable to other LMIC hospitals.

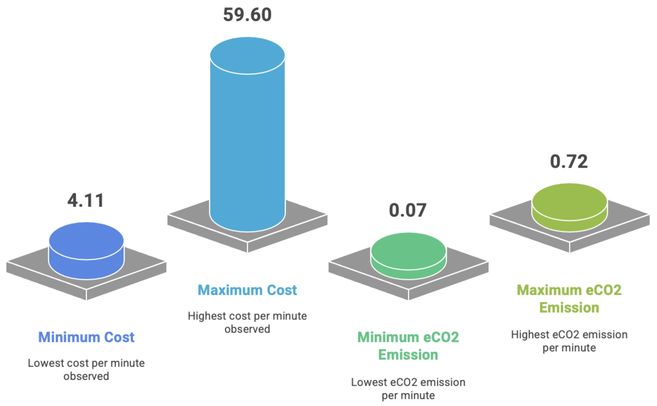
Methods

Design: Programmatic institutional case study.
Framework components (7):
1.Technology utilisation (ETC vs manual low flow)
2.Behaviour change (education, prompts, benchmarking)
3.System redesign (decommission piped N_2O)
4.Gas choice optimisation (N_2O avoidance, low-impact agents)
5.Audit–feedback loops (regular, anonymised reports)
6.Regional anaesthesia expansion
7.Consensus roadmap development
Data sources: GE Carestation™ Insights, AKDN carbon tool, procurement/cost records.
Planned outcomes: CO_2e emissions, costs, behaviour change, N_2O reduction, RA uptake.

Results

Overall burden
•Audit of 7231 cases
•Estimated annual emissions ≈ 280 tonnes CO_2e ⟶ equal to drivir a car 28 times around the Earth.

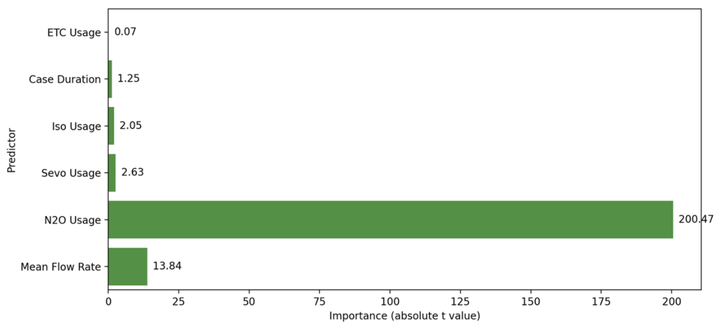
Inter Provider Comparison of Cost and eCO2 Emission per Minute



Cost and Emission Comparison: N2O Impact

Characteristic	Without N2O	With N2O
Sample Size	1009	2133
Total Cost per min (Mean ± S.D)	18.925 ± 33.417	17.692 ± 31.087
Total Emission per min (Mean ± S.D)	0.099 ± 0.056	0.498 ± 0.267

Figure 2: Predictor importance (absolute t values)



Bars display the absolute t value for each predictor (ETC Usage, Case Duration, Iso Usage, Sevo Usage, N2O Usage, Mean Flow Rate), with numeric values annotated at the end of each bar to aid comparison.

Results

Nitrous oxide
•~75% of emissions, only 4% of costs
•Procurement vs use audit: ~5× discrepancy (pipeline leakage).
•Adding N_2O increased emissions 5-fold
End-Tidal Control (ETC)
•Nitrous oxide and flow strongest predictors (R^2 up to 0.93).
Low Flow rates
•<1 L/min = 0.22 kg CO_2e/min
•≥2 L/min = 0.48 kg CO_2e/minFinal Results Gas 2.
Inter-provider variation
•Most efficient consultant = 0.07 kg CO_2e/min, 4.1 PKR/min.
•Least efficient = 0.72 kg CO_2e/min, 59.6 PKR/min ⟶ 10-fold difference.
Regional anaesthesia
•Substituting 50–90% of eligible GA cases ⟶ 33–64k kg CO_2e savings annually.
•Hip/knee substitution alone >19k kg CO_2e saved

Future Actions

Eliminate N_2O: Transition from piped to portable supply, study retrofits.
Focus on behaviour: Scale audit–feedback, education, and benchmarking.
Expand RA use: Model CO_2e savings and assess clinical feasibility.
Scale framework: Adapt for other LMIC hospitals and inform policy.

Acknowledgments

We acknowledge the Department of Anaesthesiology and Critical Care, Aga Khan University, and the Aga Khan Development Network for their support of sustainability initiatives.

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