Nitrous Oxide in a Pediatric Dental Institution: Exploring Environmental & Cost Benefits of Reduced Use

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Purpose

The primary objective of this study was to evaluate the environmental impact of nitrous oxide use in dental procedures at a pediatric dental institution, focusing on flow rates, concentration, and usage duration. Additionally, the study aimed to calculate the estimated financial and environmental costs of nitrous oxide usage, identifying opportunities to reduce emissions and areas for future research.

- the AAPD recommends a flow rate of **3-5 L/min** of Nitrous oxide for children at **30-40%** concentration[1]
- N_2O emissions, including healthcare emissions, are currently the **single most** important ozone-depleting substance emissions[5]
- Less than 5% of volatile anesthetics are metabolized by the patient, and excess gases can contribute to **environmental pollution** when exhaled[5]
- N_2O warms the atmosphere **265 times** more than CO_2[4]

Methods

Retrospective Chart Review 2018-2021

- Obtained number of nitrous encounters, dose, duration, flow

Year	Encounters (n)	Dose (%)	Duration (minutes)	Flow Rate (L/min)
2018	7,732	Range: 10-70 Mean: 49.68 Median: 50 Mode: 50	Range: 2-180 Mean: 24.38 Median: 25 Mode: 20	Range: 2-6 Mean: 5.10 Median: 5 Mode: 5
2019	8,004	Range: 40-60 Mean: 50.51 Median: 50 Mode: 50	Range: 1-305 Mean: 23.29 Median: 20 Mode: 20	Range: 2-6 Mean: 5.01 Median: 5 Mode: 5
2020	5,637	Range: 10-70 Mean: 51.47 Median: 50 Mode: 50	Range: 1-180 Mean: 24.03 Median: 20 Mode: 20	Range: 3-6 Mean: 5.00 Median: 5 Mode: 5
2021	5,564	Range: 10-70 Mean: 53.42 Median: 50 Mode: 50	Range: 1-130 Mean: 24.23 Median: 20 Mode: 20	Range: 2-6 Mean: 4.99 Median: 5 Mode: 5
Total/Mean	31,783	Mean: 51.17	Mean: 23.93	Mean: 5.03

Table 1. Provider-reported nitrous oxide administration characteristics (2018–2021): dose, flow rate, and duration from clinical encounters

Methods Continued

$$\frac{\#\text{ visits}}{} \times \frac{\text{minutes}}{1\text{ visit}} \times \frac{\text{liters x \%}}{1\text{ minute}} \times \frac{\$280.33}{13{,}800\text{L}} = \text{total cost of nitrous oxide}$$

$$\frac{\text{minutes}}{} \times \frac{\text{liters x \%}}{\text{minutes}} \times \frac{0.001977\text{kg N2O}}{1\text{ liters}} \times \frac{273\text{ kg CO2e}}{1\text{ kg N2O}} \times \#\text{ visits} = \text{total kgCO2e}$$

Figure 1. Calculation equations using nitrous oxide data and known values to find the total cost of nitrous oxide output in dollars and in kilograms of carbon dioxide equivalents

Results

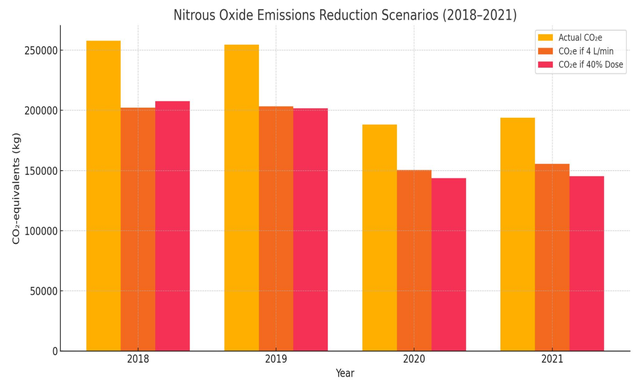

Figure 2. Nitrous oxide emissions reduction scenarios (2018–2021): impact of reduced flow rate and dose on annual co_2-equivalent emissions

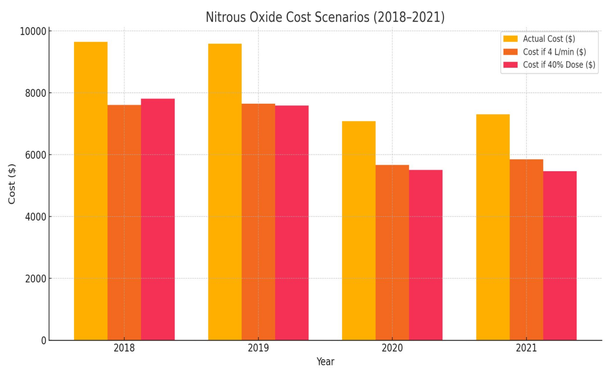

FIgure 3. Cost savings potential from nitrous oxide reduction strategies (2018–2021): annual cost comparison of actual use vs. reduced flow rate and dose

Results Continued

1 Size G Tank = 6,611 $kgCO_2e$

Carbon Impact	Actual 5L/min @50% NO	Reduce 4L/min OR 40% NO	Difference
# of Size G Tanks	138	110	**28 tanks**
kg CO_2 equivalent	912, 318	727,210 kg	**185,108**
# of homes powered in 1 year	123	97.7	**25.3**
# of drives from New York to LA	830.6	663.5	**167.1**

Table 2. Projected carbon impact equivalents and reduction potential from 138 G tanks worth of nitrous oxide used during procedures at one institution (2018–2021)

- While individual usage patterns showed considerable fluctuation, dental providers at the institution administered nitrous oxide within clinical guidelines for flow but averaged a higher dose (**Table 1**).
- A reduction in nitrous use, within the AAPD guidelines, of either 1L/min or 10% concentration produces reductions in cost and substantial reductions in carbon impact (**Fig. 2 and 3**).
- A small reduction in daily use of nitrous may have considerable environmental impacts over a 4 year span (**Table 2**).

Conclusions

- Reducing nitrous oxide use—whether by duration, flow, or dose—significantly lowers **$kgCO_2e$** emissions. Even minor reductions in volume or concentration can have substantial environmental impacts over four years.
- Significant cost savings: Lowering flow rate or dose could result in a 4-year total savings of over **$8,000**.
- More research to revise guidelines would benefit nitrous emission reduction while maintaining clinical effectiveness and minimizing chronic staff exposure.

Literature Cited

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