The Use of Nitrous Oxide for Routine Dental Treatment in Pediatric Patients with Sickle Cell Disease

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Background

- Sickle Cell Disease (SCD) is a group of inherited red blood cell disorders caused by a single gene mutation
- It is a rare disease in the U.S that disproportionally affects minorities with African Americans being most affected
- Sickled red blood cells have an abnormal hemoglobin, they are sticky, hard, and C-shaped cells which causes difficulty traveling through small blood vessels without impeding blood flow, leading to pain and health complications
- Due to their shape and abnormal hemoglobin, they die earlier and decrease available RBCs and oxygen to the body
- Nitrous oxide (N_2O) "laughing gas" is an odorless gas that produces a euphoric effect and depresses the central nervous system but has little effect on the respiratory system
- Practitioners concern with administering N_2O to SCD patients is that if they are consuming nitrous, they may be breathing in less oxygen which could cause a decrease in blood oxygenation and consequently hypoxia leading to a painful vaso-occlusive crisis or acute chest syndrome

Methods

Study Type: Case-control study

Study Design:

- Patients with SCD and their age matched controls ages 2-17 years old requiring restorative treatment at UIC pediatric dental clinics were recruited at initial or periodic exams, or at the beginning of their restorative visits
- Patients were provided nitrous oxide up to 50% N_2O and 50% O_2
- Pulse oximeter was applied at the beginning of treatment and oxygen saturation was measured before starting N_2O, at 10 min intervals throughout the procedure and after ending N_2O
- Patients with SCD received a follow-up call to assess for complications

Power Analysis: With 27 cases and 24 controls there was 90% power to detect a mean difference in O_2 of as little as 0.6 over four time periods of 10 mins each

Statistical Analysis: completed using SPSS software version 28 (IBM Statistics, Armonk, NY), repeated measures ANOVA test and Mann-Whitney test was used for analysis

Hypothesis and Objectives

Objectives:

- Identify differences in mean oxygenation levels between healthy pediatric patients and pediatric patients with Sickle Cell Disease (SCD) receiving N_2O for dental procedures.
- Determine if N_2O decreases oxygen saturation levels for patients with SCD.

Hypothesis:

- There is no difference in the mean oxygenation of healthy pediatric patients and patients that have SCD receiving N_2O for dental treatment
- N_2O does not decrease the oxygen saturation of pediatric patients with SCD

Results

Table 1: Study Demographics

	Cases N=27 (%)	Controls N=24 (%)
Age		
2-5 years	5 (18.5%)	5 (21%)
6-12 years	17 (62.9%)	15 (63%)
13-16 years	5 (18.5%)	4 (16%)
Sex		
Male	12 (44%)	11 (46%)
Female	15 (56%)	13 (54%)
Race/Ethnicity		
Black, Non-Hispanic	26 (96%)	5 (21%)
Hispanic	1 (4%)	14 (58%)
Other	0	5 (21%)
Medical Conditions other than Sickle Cell Disease (SCD)		
No	24 (89%)	21 (87.5%)
Yes	3 (11%)	3 (12.5%)

Table 3: Mean Oxygen Saturation after procedure

	Baseline O2	O2 at 10 mins	O2 at 20 mins	O2 at 30 mins
Mann-Whitney U	218.500	245.500	279.500	155.000
Wilcoxon W	596.500	623.500	657.500	308.000
Z	-2.070	-1.592	-.899	-1.192
Asymp. Sig. (2-tailed)	.038	.111	.369	.233
Exact Sig. [2*(1-tailed Sig.)]				.277[b]

a. Grouping Variable: Case or Control

b. Not corrected for ties.

Table 3: After conclusion of treatment **there was no significant difference (p=.327) in oxygen saturation between cases and controls after nitrous oxide was no longer being administered**

Figure 1: Mean Oxygen Saturation of SCD patients and controls

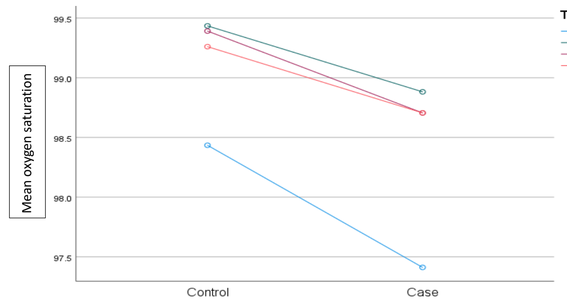

Table 2: Mean Oxygen Saturation

	O2 after procedure
Mann-Whitney U	275.000
Wilcoxon W	575.000
Z	-.980
Asymp. Sig. (2-tailed)	.327

a. Grouping Variable: Case or Control

Figure 1 and Table 2: When comparing the average O_2 saturation at baseline, 10 mins, 20 mins, and 30 mins of cases and controls, with a significance set at p<.05, **there was a significant difference at baseline** (Time 1); however, **no significant difference at 10 mins (Time 2), 20 mins (Time 3), or 30 mins (Time 4)**

Conclusions

- The use of up to 50% N_2O for dental procedures is safe in patients with sickle cell disease
- There are no adverse effects associated with the appropriate use of N_2O for patients with SCD undergoing dental treatment
- The oxygen saturation of both healthy patients and patients with SCD increase with the use of N_2O
- There are no differences in how N_2O affects the oxygen saturation levels of SCD patients compared to healthy patients
- After N_2O use ends there is no significant difference in the oxygen saturation levels of healthy patients and patients with SCD