

NITROUS OXIDE OXYGEN INHALATION SEDATION IN PEDIATRIC DENTISTRY

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ABSTRACT

Objective: To evaluate the effectiveness of nitrous oxide oxygen inhalation sedation as an adjunct to dental behaviour management and allowing the treatment to be carried out for children.

Methods: The dental records of 224 patients, belonging to healthy children were examined.

Results: The administration of nitrous oxide-oxygen gas mixtures in the range of 30%-39% profoundly influenced the behaviour of anxious children enabling them to co-operate and allow satisfactory dental treatment to be carried out. There was a significant relationship between the use of local anesthesia and the successful outcome of treatment. The acceptance of inhalation sedation was not related to the gender of the patient. There was a significant relationship between the age of the patient and success of inhalation sedation.

Conclusion: Nitrous oxide was found to have significant effect on uncooperative child behaviour.

Key words: Inhalation sedation, Nitrous oxide, Pediatric dentistry

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Introduction

Inhalation sedation utilizing nitrous oxide and oxygen has been a primary technique in the management of dental fears and anxieties for more than 150 years and remains so today.^(1,2) The terms “nitrous oxide sedation”, “relative analgesia (RA)” and “inhalation sedation” are frequently used to describe the same technique. Though earlier recommendations suggested an upper limit of 30% nitrous oxide,⁽³⁾ it has been recognized that flexibility may be required and a more recent recommendation justifies an upper limit of 70% nitrous oxide, 30% oxygen.⁽⁴⁾

Sedation by the introduction of nitrous oxide is relatively safe, simple and is effective in reducing the anxiety and fear in patients.⁽⁵⁾ Increasing awareness of the potential risks of dental general anesthesia (DGA) led to the development of

an Expert Working Party to assess the future of DGA in dentistry in the UK.

One of its principal recommendations was avoidance of DGA and the use of alternative techniques whenever possible.⁽⁴⁾ The mean cost of sedation was one-third that of general anesthesia.⁽⁶⁾

Inhalation sedation with nitrous oxide-oxygen has proved to be one of the most effective techniques for the reduction of stress in the apprehensive or medical risk patient.⁽²⁾ When highly anxious children are treated with nitrous oxide for a number of consecutive sessions, their anxiety remains significantly lower during a following control period even without the use of nitrous oxide.^(7,8)

Inhalation sedation using nitrous oxide is widely used in dentistry to alleviate dental anxiety and improve patient cooperation.⁽⁹⁾

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Table I. A summary of the outcomes of the treatment plan for the 200 patients scheduled for sedation

Treatment outcome	Subjects	
	n	%
All treatment completed	153	76.5
Referred to DGA	35	17.5
Failed subsequent appointment	12	6
Total	200	100

Table II. Gender of children related to treatment outcome

Gender	Completion		DGA*		FTA**		Total	
	n	%	n	%	n	%	n	%
Male	76	49.7	20	57.2	7	58.3	103	51.5
Female	77	50.3	15	42.8	5	41.7	97	48.5
Total	153	100	35	100	12	100	200	100

P> 0.05

*DGA: Dental general anesthesia **FTA: Failed to attend

Nitrous oxide-oxygen sedation for pediatric patients is an essential tool in anxiety management and is used as an adjunct to behavioural management.⁽¹⁰⁾

Methods

Records of children, aged 6-15 years, who were treated by postgraduate students and Senior House Officers in the Pediatric Dentistry Department of the Liverpool University Dental Hospital between March 1, 2003 and March 30, 2004 after being referred by General Dental Practices and Community Dental Service Clinics because of inability to co-operate with dental treatment were reviewed. Children whose dental records mentioned learning difficulty were excluded from the study. The dental records of 224 patients, belonging to healthy children, were examined.

The collected data (Appendix 1) were edited, coded and entered on a PC and analyzed with the SPSS statistical package, version 11.

Results

Eighteen patients were excluded from the study, because of their age, 11 patients were older than 15 years and seven were younger than six years. Six patients were also excluded from the study because it was not possible to complete the data from the dental records.

The main study group therefore consisted of a total of 200 patients who attended the clinic for treatment with inhalation sedation. These patients had a total of 389 visits.

Table I is a summary of treatment outcome for the 200 patients for whom treatment with inhalation sedation was planned. For 153 (76.5%), all the planned treatment was completed using inhalation sedation. There were thirty five (17.5%) patients

who could not complete treatment in this way and were subsequently treated using Dental General Anesthesia (DGA). The remaining twelve patients (6%) did not complete treatment because they failed to attend second or subsequent visits, having previously accepted part of the planned treatment successfully. For those thirty five patients who were referred on for DGA, twenty four were sent because treatment had to be abandoned at the first visit, five at the second visit, two at the third visit and four at the fourth visit. The reasons for abandoning treatment for these patients were: "Refusal of sedation" by five patients; "Refusal of local anesthesia" (LA) (despite acceptance of sedation) by seventeen patients; "Refusal of extraction" (despite adequate LA and acceptance of sedation) by six patients; "other" reasons for seven patients. For four of these seven patients there was inadequate analgesia, two patients for extraction and two patients for endodontic treatment. The remaining three patients became very nervous and started crying. For the twelve patients who failed to attend to complete their treatment, six failed to return for a second visit, four for a third visit and two for a fourth visit.

Factors Related to the Outcome of Proposed Treatment with Inhalation Sedation and General Anesthesia:

I. Gender

The study group of children consisted of 103 (51.5%) males and 97 (48.5%) females. It is shown in Table II that of the 153 children who completed their treatment plans, there were seventy six males and seventy seven females.

Of the thirty five patients referred on for DGA there were twenty males and fifteen females. Of the twelve patients who did not complete their treatment plans, there were seven males and five females.

Table III. Percentage of nitrous oxide used for patients who completed treatment

% of N ₂ O	Patients	
	n	%
20-29	30	19.6
30-39	116	75.8
40-45	7	4.6
Total	153	100

Analysis of these results showed that there was no statistically significant relationship between the gender of the child and the management technique ($P > 0.05$).

II. Age

The mean age of patients who completed their treatment plans is 25.7 months (SD 34.51). The forty seven patients for whom treatment was not completed with sedation, their mean age was 103.5 months (SD 23.42). Analysis of the data demonstrated that there was a statistically significant difference in age between the two groups ($p < 0.05$).

III. Concentration of Nitrous Oxide

Table III shows the percentage of nitrous oxide for patients who completed their treatment plans. Of these 153 patients, 30 (19.6%) received 20-29% nitrous oxide, 116 (75.8%) received 30-39% nitrous oxide and 7(4.6%) received 40-45% nitrous oxide. The minimum concentration used was 20% and the maximum concentration was 45%.

IV. Local Anesthesia

Of the 177 patients who were treated with LA, 152 (85.9%) completed treatment. LA was not used for twenty three patients. Only one (4.3%) of these completed the treatment plan. Of the twenty two patients for whom LA was not possible, seventeen were referred to DGA and five did not return for treatment in the study period. There was a statistically significant difference between patients treated with LA and those patients for whom it was not possible to use LA ($P < 0.05$).

Discussion

The age group chosen was children between six and fifteen years old. This range was chosen because younger children are more likely to require DGA, while older children may accept treatment with local anesthetic only.⁽¹¹⁾

The overall success rate of 76.5% of patients completing all their planned treatment is comparable

to that of most previously reported studies relating to the efficacy of treatment with inhalation sedation, Roberts *et al.*,⁽¹²⁾ Lindsay and Roberts⁽¹³⁾ and Bryan.⁽¹¹⁾

Forty-seven of the 200 patients did not complete their treatment. However, it must be noted that failure rate of 23.5% included twelve patients (6%) who failed to attend for second or subsequent visit having previously accepted part of the planned treatment successfully. The reasons for this failure to return for completion of treatment were not investigated.

Thirty-five of the patients (17.5%) could not cope with treatment using sedation and were subsequently treated using DGA. This result implies that there will always be a small number of patients for whom treatment with inhalation sedation will be unsuccessful. This contrasts with DGA, where a competent anesthetist may be able to induce most children, because co-operation is necessary for only a very short time before loss of consciousness. It is therefore of value to examine the factors associated with success in this study.

Analysis of the results showed that there was no relationship between gender and the management technique.

Children at the upper limit of the age group might have been expected to have a more favorable attitude towards inhalation sedation. This study confirmed that the likelihood of success is related to the age of patients and it was shown that the patients who failed to complete their treatment were approximately two years younger than those who completed their treatment.

The results of this study demonstrated that there was a statistically significant difference between the mean age of patients who completed treatment compared with those who did not. Weinstein *et al.*⁽¹⁴⁾ noted that children under six years of age did not respond to inhalation sedation and Hallonston *et al.*⁽¹⁵⁾ also found a lower acceptance level with younger patients. The findings of the dental assessment raise a number of important issues related to the concentrations of nitrous oxide recommended. A fixed concentration 25% nitrous oxide has been suggested by Edmund and Rosen.⁽¹⁶⁾ It is apparent that if this concentration was used, it would be insufficient for large number of patients. A maximum concentration of 50% has been suggested by Young, O'Mullane and Warren.⁽¹⁷⁾

This concentration was not used for any patient in this study, and the average concentration used for

patients completing their treatment plans was 30.25% nitrous oxide with 75.8% of patients receiving 30-39% of nitrous oxide. His supports the idea suggested by Bennett⁽¹⁸⁾ that adequate sedation is likely to be achieved for most patients when inhaling between 30% and 35% nitrous oxide, also Stanley and Morris⁽²⁾ ascertained that the typical inhalation sedation patient requires 30-40% nitrous oxide. Compared to this study, Roberts *et al.*⁽¹²⁾ reported a higher concentration, of 47-50%. They also suggested the need for even higher concentrations. However, Hallonsten *et al.*⁽¹⁵⁾ demonstrated that concentrations higher than 60% nitrous-oxide are not necessary with slow introduction and without the use of an air dilution port.

This study showed a highly statistically significant difference between patients treated with LA and patients for whom it was not possible to use LA. Nitrous oxide-oxygen sedation was supplemented with LA in 88.5% of the patients where operative dentistry or dental extraction was performed, to achieve satisfactory pain control. The use of LA is supported by Trieger *et al.*⁽¹⁹⁾ who concluded that supplementation with local analgesia is frequently necessary to obtain sufficient pain control in both operative dentistry and oral surgery. LA was not used for 23 (11.5%) study patients. Most of those were referred to DGA.

Conclusion

It was possible to treat a large proportion of the patients using this alternative approach, who would otherwise need DGA.

The administration of nitrous oxide-oxygen gas mixtures in the range of 30%-39% profoundly influenced the behaviour of children enabling them to co-operate and allow satisfactory dental treatment to be carried out. There was a significant relationship between the use of LA and the successful outcome of treatment.

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(Appendix 1)

Study Data Collection Sheet

1. Identity Number
2. Date of Treatment Plan
3. Was the Treatment Plan Completed Yes No
4. Patient Referred to GA Yes No
5. Complication (Description)
6. Gender
7. Age (In Months)
8. No of Episode of Treatment Using IHS
9. % of N2o Administered (Average Over All Visits)
10. Lowest
11. Highest
12. Average
13. Technique of LA INF IDB Both
- * Operators
14. Post Grad
15. S H O