

Scientific Article

Fasting State and Episodes of Vomiting in Children Receiving Nitrous Oxide for Dental Treatment

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Abstract: **Purpose:** The purpose of this controlled-crossover study was to determine the frequency of vomiting during nitrous oxide / oxygen analgesia (NOA) and assess the relationship between fasting status and vomiting. **Methods:** One hundred and thirteen children (64 male, 49 female), ranging in age from 24-160 months (mean=74) and a mean weight of 23 kg (range 11-60 kg), participated in the study. At the initial examination, subjects were randomly assigned to be either fasting on the first appointment and non-fasting during the second appointment or alternatively be non-fasting for the first appointment and fasting for the second. **Results:** The average time interval between eating and treatment in the fasting sessions was 6 hours and in the non-fasting group, 1 hour before treatment. Vomiting occurred in only one subject, immediately after cessation of treatment resulting in a frequency of 1% of subjects or 0.5% of sessions. No other differences were found between fasting and non-fasting subjects. **Conclusion:** During dental treatment with NOA using the rapid induction method, constant nonfluctuating concentration/flow, and treatment time of under 35 minutes, the frequency of vomiting during NOA was found to be 0.5 %. (*Pediatr Dent* 2008;30:414-9) Received July 18, 2007 | Last Revision October 23, 2007 | Revision Accepted October 24, 2007

KEYWORDS: CHILDREN, NITROUS OXIDE, FASTING, ADVERSE

Nitrous oxide/oxygen analgesia (NOA) is used routinely for the dental treatment of anxious or uncooperative pediatric patients.^{1,2} In many instances, it is used alone without any supplemental oral premedication. The adverse effects of NOA, which appear to be minor, include nausea and vomiting.³

The American Academy of Pediatric Dentistry (AAPD) and the American Academy of Pediatrics jointly have developed and published guidelines for monitoring and managing pediatric patients during and after sedation for diagnostic and therapeutic procedures.^{4,5} Regarding preprocedural fasting (PF) requirements for all sedation levels—including minimal sedation (old terminology “anxiolysis”) and moderate sedation (old terminology “conscious sedation” or “sedation/analgesia”)—they have endorsed the American Society of Anesthesiologists’ (ASA) guidelines.⁶

The American College of Emergency Physicians (ACEP) published similar guidelines for monitoring and management of sedation for diagnostic and therapeutic procedures.⁷ These stringent fasting guidelines, originally formulated for use before

general anesthesia (GA), have been extended outside the operating room to include procedural sedation. The guidelines recommend an empty stomach prior to GA or deep sedation to prevent pulmonary aspiration, although it is a very rare event in the pediatric population.^{8,9}

Conversely, the ASA guidelines state that there is insufficient data to test the hypothesis that PF results in a decreased incidence of adverse outcomes in patients undergoing sedation and analgesia (as distinct from patients undergoing GA).⁶ The ACEP guidelines are also ambiguous, stating: “Recent food intake is not a contraindication for administering procedural sedation and analgesia, but should be considered in choosing the timing and target level of sedation.”⁷ The literature does not provide sufficient evidence to test the hypothesis that PF results in a decreased incidence of outcomes in patients undergoing either moderate or deep sedation.¹⁰ Recent medical studies have indicated that there is no association between PF and adverse events and that no complications were related to inadequate fasting times.¹⁰⁻¹³

Many studies were conducted primarily in emergency room departments due to the difficulties often encountered in the application of the ASA guidelines in children who have not fasted and require urgent or emergent procedures. Among fasting and non-fasting children who underwent procedural sedation in the emergency room, Agrawal et al found no difference regarding airway complications, emesis,

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or other adverse effects.¹⁴ Another study examining children undergoing sedation for orthopedic procedures found no association between the duration of fasting and the occurrence of emesis.¹⁵ Ghaffar et al compared children who had fasted less than 2 hours with those fasting more than 2 hours who were sedated for an echocardiogram. They did not find any significant difference in the emesis rates between the 2 groups.¹¹ Keidan et al found that patients who fasted prior to sedation with chloral hydrate had a significantly higher sedation failure rate, needed higher doses of chloral hydrate, and, consequently, were sedated for longer periods compared with infants who were fed prior to the sedation. No significant differences in the incidence of adverse effects, however, were found in either group.¹⁶

The use of nitrous oxide in dentistry is widespread. Its use is less common in medical procedures. The relationship between fasting status and adverse events during procedural sedation and analgesia with nitrous oxide alone during medical procedures has only recently been studied.¹⁷ Many studies of nitrous oxide use as an analgesic/sedative agent during medical procedures do not include fasting information.¹⁸⁻²⁵ In 2 studies that used 50% NOA, patients had not fasted.^{26,27}

In 3 studies that used 30% to 50% NOA, patients had fasted for 2 hours.²⁸⁻³⁰ In one study that used 50% to 70% NOA, patients fasted from solids for 4 hours and from clear liquids for 2 hours.³¹ None of these studies investigated the relationship between fasting and adverse events. Babl et al examined the relationship of PF status among pediatric patients receiving NOA in the emergency department and the occurrence of adverse events.¹⁷ No association was found between procedural fasting and emesis. Seventy-one percent of the children did not meet established fasting guidelines. No incidents of pulmonary aspiration were observed. Seven percent of the patients experienced emesis episodes. Of these, 80% vomited during NOA administration itself; the rest vomited after the procedure was completed and before discharge.

The relationship between PF and episodes of vomiting during dental treatment of pediatric patients was investigated over 30 years ago. The study reported a 10% frequency of vomiting in children who received NOA for dental treatment.³² Malamed³³ stated that large studies show that nausea and vomiting occur in fewer than 1% of patients. These studies have remained unpublished. No other studies have been published examining the need to apply PF to children undergoing dental treatment with NOA alone.

The AAPD guidelines for the appropriate use of NOA for pediatric dental patients remain vague regarding the need for PF when administering NOA alone.³⁴ The guidelines state that PF is not required for patients undergoing NOA/anxiolysis. Conversely, they also state that the practitioner may recommend that only a light meal be consumed in the 2 hours prior to NOA administration. No controlled study is referenced supporting these recommendations.

This study's purpose was to investigate the association between preprocedural fasting and the frequency of vomiting in pediatric patients receiving dental treatment with NOA.

Methods

The experimental protocol was approved by the Institutional Human Subjects Ethics Committee of Hebrew University—Hadassah School of Dental Medicine, Jerusalem, Israel. Informed consent was obtained from all parents/legal guardians of participating subjects.

Subjects. Participating in this institutionally-approved study were 113 children (64 males and 49 females), ranging in age from 24 to 160 months with a mean age of 74 months and a mean weight of 23 kg (range 11-60 kg). These children were selected consecutively as they presented for treatment at the graduate student pediatric dental clinic of the Department of Pediatric Dentistry, Hebrew University- Hadassah School of Dental Medicine or at the private dental practices of the authors.

Requirements for participation were: the child was in good health (ASA 1); at least 2 separate restorative dentistry appointments were required; and NOA inhalation was necessary to manage uncooperative or anxious behavior as determined during the detailed oral examination, which included necessary radiographs.

Preprocedural fasting. Prior the first session subjects were NPO as per the AAPD's 2006-07 guidelines for sedation.⁴ All subjects were instructed to refrain from consuming solids (including milk) for at least 6 hours prior to NOA and to refrain from clear liquids 2 hours before treatment. On the alternative session, the subjects were given no restrictions on their food or liquid intake. Thus, a crossover design was used with all 113 subjects, who participated in 226 treatment sessions. This experiment was designed so that each subject served as his/her own control with the same operator, and similar types of procedures were performed during both treatment sessions. At the initial examination, subjects were randomly assigned to either fast on the first appointment and not fast during the second appointment or else not fast for the first appointment and fast for the second appointment.

At the restorative visit, NOA was administered via a nitrous oxide scavenger mask at an initial standard flow rate of 50% nitrous oxide at 5 L/minute for 5 minutes. The flow rate was individually titrated as necessary. The practitioner then administered local anesthetic and proceeded with the planned restorative dental treatment. A rubber dam was used for all restorative procedures. Continual clinical observation of the patient's responsiveness, color, and respiratory rate and rhythm was performed according to AAPD guidelines. At the completion of restorative treatment, 100% oxygen was administered for up to 5 minutes.

Table 1. SAMPLE DEMOGRAPHICS (N=113)

Mean age (mos±SD)	74.0±26.6	
	Age group (mos)	No. of subjects
	24-60	44
	60-96	48
	>96	21
Gender	64 males, 49 females (N=113)	
Weight (kg±SD)	22.5±8.2	
Vomiting tendency* N(%)	16 (14)	
Previous nitrous oxide experience; N (%)	55 (49)	

* Vomiting tendency was defined as tendency for car sickness/other vomiting experiences.

Table 2. PARAMETERS OF FASTING VS NON-FASTING SESSIONS OF DENTAL TREATMENT WITH NITROUS OXIDE / OXYGEN ANALGESIA

	Fasting session*	Non-fasting session
Fasting time (hs)	6.3±3.2	1.2±0.69 †
% nitrous oxide/oxygen	50±2.0	50±1.3
Nitrous oxide flow (L/min)	5.5±0.8	5.5±1.0
Total duration of nitrous oxide administration (mins±SD)	27±9.3	27±8.7
Change in flow	None	None
Local anesthesia (carpules±SD)	1.0±0.3	0.9±2.0
Total treatment time (mins±SD)	32.0±9.0	31.0±8.0
Vomiting (%)	None	1 (1)

* Data are presented as mean + SD

† Statistically significant; P<.001; ANOVA with repeated measures.

Table 3. PROFILE OF SUBJECT WHO EXPERIENCED AN EPISODE OF VOMITING DURING DENTAL TREATMENT WITH NITROUS OXIDE / OXYGEN ANALGESIA

Age (mos)	99	
Gender	Male	
Weight (kg)	23	
Vomiting tendency	No	
Previous nitrous oxide experience	Yes	
	First visit: Fasting	Second visit: Nonfasting
Time of treatment	5:30 p.m.	5:30 p.m.
Fasting time (hs)	5	1
Nitrous oxide (%) / flow (L/min)	50/5	50/5
Total duration of nitrous oxide (mins)	30	35
Type of treatment	Extraction, pulpotomy, and stainless steel crown	Pulpotomy and stainless steel crown
Vomiting	No	Yes, immediately following treatment

Evaluation. A survey was given to parents prior to treatment, and information regarding the following was recorded: age; weight; previous NOA experience; history of vomiting or nausea (motion sickness, foods, etc); all food intake prior to the dental appointment, including time the item was consumed, item consumed, method of preparation, and amount consumed; duration of inhalation administration; percentage of NOA and flow rate (steady or fluctuating); treatment type rendered; amount of local anesthetic administered; and total treatment time.

In addition to recording the occurrence of vomiting during or immediately following treatment, patients were called on the treatment day and asked if any vomiting or nausea occurred at home.

Statistical methods and analysis.

Statistical analysis of data determined the incidence of vomiting and if any significant differences between the 2 sessions occurred. Statistical analysis was performed using SPSS statistical software 14.0 (SPSS, Inc, Chicago, Ill). To evaluate differences between fasting and non-fasting sessions for quantitative variables, the analysis of variance model with repeated measures was applied. In this model the differences were tested and corrected for order of treatment protocol. To compare qualitative variables between fasting and non-fasting sessions, the McNemar test was used. The effect of treatment order was tested by using the 2-sample t test for quantitative variables and the chi-square test for qualitative variables. All tests applied were 2-tailed, and a P-value ≤.05 was considered statistically significant.

Results

The sample’s descriptive measurements are presented in Table 1. Sixteen subjects (14%) reported a tendency for car sickness/vomiting experiences, and approximately half (49%) of the children had previous experiences of NOA during dental treatment. All restorative treatment goals were successfully completed in all patients.

No significant differences were found for any parameter (eg, nitrous oxide flow, treatment time, type of treatment) between fasting and non-fasting sessions, other than the time interval between commencement of treatment and last food intake (P<.001). The average time interval was 6 hours in the fasting sessions and 1 hour before treatment in the non-fasting group.

Vomiting occurred in only 1 subject, immediately after cessation of treatment, resulting in a frequency of 1% of subjects or less than 1% of sessions (Table 3). This 8-year, 3-month-old patient vomited during his second (non-fasting) session. Prior to this session, the patient had eaten a heavy lunch followed by a late afternoon snack of chocolate pudding 1 hour prior to treatment.

Discussion

As aforementioned, the reason for fasting restrictions prior to GA is related to aspiration pneumonia. Pulmonary aspiration is a rare event—occurring, according to at least one estimation, in approximately 1 in 10,000 cases.³⁵ Decreasing gastric contents is believed to minimize the risk of aspiration pneumonia. A prolonged fasting time theoretically decreases the risk of aspiration by providing low gastric volumes.¹¹ Studies in children undergoing GA, however, have proven that, despite a prolonged fast, children exhibit a large acidic residual gastric fluid volume at the time of induction.^{36,37} Furthermore, prolonged fasting periods increase gastric acidity without significantly affecting the volume. It has not been possible to define the minimum volume that a patient must aspirate before manifesting sequelae of aspiration. Thus, it is suspect to declare patients at risk of developing aspiration pneumonia on the full or partial basis of their residual gastric volume.³⁸

A study by Ingebo et al investigated the relationship between the duration of time that children fasted before a procedure and their gastric volume and pH at the time of the procedure.³⁹ The authors concluded that: fasting longer than 2 hours after ingesting clear liquids does not significantly change gastric volume or pH; there is no advantage in requiring children to fast for longer than 2 hours after clear liquid ingestion before sedation or anesthesia for any procedure; and fewer than half of pediatric patients actually achieve the “desirable” values of a gastric volume of 0.4 ml/kg or less and a pH value of 2.5 pH units or more, regardless of fasting duration, even though these values are presented in the literature as a goal to minimize the risk of aspiration pneumonia.

A controversy may exist among pediatric dentists and pediatric dental departments regarding the need to apply PF or other limitations on children undergoing dental treatment with NOA alone. As aforementioned, the AAPD guidelines reflect this dilemma. They stated that no fasting is required, but added that the practitioner may recommend that only a light meal be consumed in the 2 hours prior to the NOA administration. These guidelines have essentially been adopted from the previously published UK National Clinical Guidelines in Paediatric Dentistry.⁴⁰ These ambiguous recommendations differentiate between sedation and NOA inhalation alone: “Fasting is not required for children undergoing inhalation sedation using nitrous oxide, but dentists might recommend that a light meal only be consumed in the two hours prior to the appointment.”

PF advocates may argue that the foremost adverse reaction associated with NOA is vomiting and, therefore, the patient should not be treated if he or she ate before treatment. Dentists who oppose fasting for the use of NOA may reason that the incidence of vomiting is very low and, in the event of such an occurrence, no life threatening risks exist since the patient is not deeply sedated and remains in control of all reflexes, unlike the deeply sedated child. Aspiration of vomitus is unlikely when the protective airway reflexes are intact. Consequently, pulmonary aspiration is highly unlikely to occur.

In addition, a fasting child may be agitated and will be less cooperative during dental treatment, thus defeating the purpose of NOA use. Unfed children are often cranky, sometimes combative, and occasionally dehydrated.⁴¹ Consequently, the dentist may decide to use a higher NOA concentration to overcome this child's disruptive behavior. The higher dose may result in oversedation, which in itself can cause vomiting. Indeed, a study of pediatric sedation with choral hydrate found that implementation of fasting guidelines resulted in the administration of higher doses of sedatives. Hence, this may affect the potency of protective airway reflexes and increase the likelihood and incidence of pulmonary aspiration.¹⁶ The study concluded that fasting had a negative effect on the procedure. The authors presumed that this was a result of the fact that a hungry child is irritable and therefore more difficult to sedate. Another paradox to be considered is that patients treated on an empty stomach are more susceptible to nausea and vomiting.³³

Malamed suggested that history has in some areas persisted in the erroneous conclusion that NOA was the cause of nausea and vomiting.³³ Rather, nausea and vomiting occur during NOA as a result of hypoxia or oversedation. When nausea occurs, it is usually associated with the following causes: oversedation (nitrous concentration too high for patient); the “roller coaster” effect of sharp increases and decreases in concentrations of NOA administered⁴²; sedation length—the longer the patient has NOA, the greater the incidence of nausea and vomiting⁴³; and a prior history of nausea and vomiting. Some children are more prone to nausea and vomiting.³² The use of an antiemetic may be considered in these patients.

Another factor that has been suggested as increasing the frequency of vomiting during NOA is middle ear pressure. An interesting study was designed to explore the relationship between changes in middle ear pressure associated with inhalation anesthesia and the incidence of postoperative nausea and vomiting.⁴⁴ Middle ear compartment pressures were measured by tympanometry in 27 randomly assigned knee arthroscopy patients throughout the surgical procedure and into recovery. A positive correlation was demonstrated between the maximum positive pressure and maximum negative pressure gradient and postoperative nausea and vomiting. The study concluded that middle ear barometric changes contribute to the incidence of postoperative nausea and vomiting induced by NOA.

Precautions. The frequency of vomiting during NOA in the present study was less than 1% and was significantly lower than the previously reported frequency of 10%.³² This study's average 30-minute length of NOA, however, was relatively short. In addition, the rapid induction method was used and no fluctuations of NOA concentration occurred. All of these factors may have contributed to the low frequency of vomiting. This study's results may not be extrapolated to treatment sessions of significantly longer duration.

The highest nitrous oxide concentration used in this study was 50%. Clinicians using higher concentrations need to be aware of and prepare for the potential to cause moderate to deep sedation. Higher concentrations may be associated with an increased risk of adverse events in general—particularly increased episodes of emesis.¹⁷

Dentists using NOA need to be prepared to manage vomiting. Aspiration of vomitus is unlikely when the protective airway reflexes are intact. If the patient reports a feeling of nausea, the NOA should be turned off and 100% pure oxygen administered. Should vomiting occur, the nasal hood and rubber dam should be removed. The patient's head should be turned to the side, away from the operator, allowing the vomitus to pool in the patient's cheek and not in the pharynx. The mouth should be suctioned and oxygen should be administered for at least 3 to 5 minutes.^{33,45}

Limitations. Due to the very low incidence of vomiting found in this study, an extremely large sample is required to detect further differences and significant relations between vomiting and parameters such as fasting, tendency to vomit, nitrous oxide concentration, and duration of treatment. This study's results may not be applied to treatment sessions exceeding 35 minutes.

Conclusions

During dental treatment with nitrous oxide/oxygen analgesia using the rapid induction method, constant nonfluctuating concentration/flow, and a treatment time of fewer than 35 minutes, the frequency of vomiting during NOA was found to be less than 1%. No differences were found between fasting and nonfasting subjects.

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