

## Effects of Eliminating Nitrous Oxide in Outpatient Anesthesia

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Nausea and vomiting are the most common complications of outpatient general anesthesia.<sup>1</sup> An ideal anesthetic technique would minimize nausea and vomiting, be easy to use, allow for rapid discharge of patients, and prevent patient recall of potentially unpleasant intraoperative events. Nitrous oxide has been implicated as having emetic potential for numerous reasons.<sup>2-6</sup> The following study was designed to determine the effect of omitting nitrous oxide from a general anesthetic technique. The incidence of postoperative nausea and vomiting, common postoperative complications, and intraoperative recall were compared when using two general anesthetic techniques for minor surgical procedures in healthy females.

## MATERIALS AND METHODS

Sixty female outpatients, ASA classification I or II, undergoing minor procedures (dilatation and curettage [D&C], therapeutic abortion [D&E&C], cone biopsy, and laser ablation vulvar lesions) were divided according to year of birth (odd or even) into two groups. The study was approved by the hospital committee on human experimentation. Informed consent was obtained. Patients with a history of motion sickness or severe postoperative nausea in the past were not admitted into the study. No patient had preoperative nausea. All patients had an 18-gauge intravenous catheter, continuous electrocardiogram, precordial stethoscope, and automated blood pressure cuff. Anesthesia was induced by thiamylal sodium 5-7 mg/kg iv. No patient was premedicated. Group I patients received isoflurane in oxygen (5 l/min) originally at 3% which was decreased as appropriate for completion of surgical procedure and maintaining stable vital signs. Group II patients received isoflurane 1.5% in 60% nitrous oxide and oxy-

gen (3:2 l/min) with the isoflurane concentration decreased as appropriate for the surgical procedure. All patients were allowed to breath spontaneously with assisted ventilation *via* face mask using a semi-closed circle system. No patient received any other intraoperative medications. At the end of the procedure, all patients breathed 100% oxygen for 5 min, and were then transferred to the recovery room. Duration of anesthetic (induction until cessation of anesthetic gases) was noted.

In the recovery room, patients were evaluated for nausea and vomiting, pain, and level of consciousness every 15 min by a trained recovery room nurse who was unaware of the method of anesthesia used. Level of consciousness was recorded as awake, drowsy, or asleep. If a patient vomited or spontaneously complained of nausea or pain, this was marked. Every 15 min, each patient was asked, "Are you comfortable?". If she said yes, she was not questioned for 15 more minutes. If the patient replied no, she was asked, "Do you feel sick to your stomach or does something hurt?". Responses to these questions were recorded. Any patient requesting pain medication was given 400 mg ibuprofen orally. Patients were discharged when they were ambulatory, had stable vital signs, and minimal nausea. The discharging anesthesiologist was unaware of the anesthetic technique used. The time from arrival in the recovery room until discharge home was considered discharge time. Twenty-four hours postoperatively, every patient was called by a trained nurse as part of a routine postoperative call. This call included questions on post-discharge pain and nausea. During this phone call, every patient was asked to state the last thing she remembered as she was receiving her anesthetic and the first thing she remembered after that. These responses were also recorded.

Continuous variables were compared by unpaired *t* test and discrete variables by Fisher's Exact Probability Test. Discharge times were also analyzed with the Wilcoxon Rank Sum test. A value of  $P < 0.05$  was considered significant.

## RESULTS

Twenty-eight patients were assigned to group I and 32 to group II. Surgical procedures in group I were 19 D&Cs, one D&E&C, four cone biopsies, and four laser of vulva. Group II had 22 D&Cs, one D&E&C, five cone biopsies, and four laser of vulva. There were no differ-

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ences between the groups in this regard. Patients were similar with regard to age, height, weight, anesthetic time, and recovery time (table 1). There was no difference in level of consciousness between the two groups during any time interval. On admission to the recovery room, 13 patients in group I and 11 in group II were considered to be asleep, while five in group I and eight in group II were considered to be drowsy. By 30 min, no patient was asleep, and five in group I and seven in group II were drowsy. By 60 min, all were awake. The number of patients complaining of pain and requesting pain medications was also similar in both groups (table 2).

All patients who complained of nausea eventually vomited. Twenty-five percent of group II patients had nausea and vomiting, compared to only 3.6% of group I patients ( $P < 0.05$  [table 2]). Comparison of patients who had nausea and vomiting with those who did not showed a significantly longer recovery room stay in patients with emetic symptoms (table 3). The single group I patient who vomited in the recovery room also vomited during the ride home. One group II patient was nauseated during her ride home, and another was nauseated briefly the next morning. Neither of these patients vomited. No patient reported recall of any events between anesthetic induction and awakening in the recovery room.

### DISCUSSION

Nitrous oxide can cause emetic symptoms *via* several mechanisms, both peripheral and central. It diffuses into the gastrointestinal tract more quickly than nitrogen can diffuse out, resulting in bowel distention which can lead to nausea and vomiting.<sup>2</sup> It can diffuse into the middle ear, greatly increasing pressure there.<sup>3</sup> It can also interact centrally with the endogenous opioid receptor systems,<sup>4-6</sup> thereby stimulating nausea and vomiting at this level.

Several conflicting studies have recently appeared concerning the role of nitrous oxide in causing postoperative nausea and vomiting. Alexander *et al.*<sup>7</sup> found that patients undergoing laparoscopy with nitrous oxide and fentanyl anesthesia had a higher incidence of nausea and vomiting than patients receiving either isoflurane alone or isoflurane and fentanyl anesthesia. Lonnie and Harper<sup>8</sup> also found that addition of nitrous oxide to an anesthetic of enflurane and fentanyl for laparotomy patients increased postoperative nausea and vomiting. Rising *et al.*<sup>9</sup> found that post-laparoscopy emetic symptoms are greatly increased when fentanyl is used as opposed to isoflurane as part of the anesthetic technique.

Korttila *et al.*<sup>10</sup> found that omission of nitrous oxide did not decrease emetic symptoms in patients undergo-

TABLE 1. Patient Height, Weight, Age, Anesthesia, and Recovery Time ( $\pm$ SD)

	Group	
	I	II
N	28	32
Ht. (cm)	137.8 $\pm$ 8.3	135.3 $\pm$ 8.6
Wt. (kg)	61.4 $\pm$ 14.3	63.2 $\pm$ 11.1
Age (yr)	31.8 $\pm$ 9.2	35.1 $\pm$ 6.4
Anesth time (min)	13.2 $\pm$ 6.1	12.6 $\pm$ 6.4
Recovery (min)	119.7 $\pm$ 35.9	134.5 $\pm$ 33.1

Results were not statistically significant.

TABLE 2. Pain, Nausea, and Vomiting (%)

	Group	
	I	II
N	28	32
#Pts. reporting pain	9 (28.8%)	10 (31.3%)
# Pts. requesting analgesics	7 (22.4%)	7 (21.9%)
# Pts. with nausea & vomiting	1 (3.2%)*	8 (25%)

\*  $P < 0.05$ .

ing abdominal hysterectomy. Muir *et al.*<sup>11</sup> had similar findings in a group of pediatric patients undergoing various surgical procedures. All of these studies involve several factors which may obscure the influence of nitrous oxide on nausea and vomiting. All involved the intraoperative use of narcotics. Since nitrous oxide can cause emetic symptoms by interaction with opioid mu receptors,<sup>4-6</sup> intraoperative narcotics may alter this response. All of the anesthetic techniques involve the use of muscle relaxants and endotracheal intubation. Many surgical procedures were intraabdominal, and variations in surgical technique could influence postoperative nausea and vomiting. Finally, postoperative pain, which can be severe after laparoscopy or hysterectomy, can also influence postoperative emetic symptoms.<sup>12</sup> All of our procedures were peripheral; none required endotracheal intubation; our anesthetic technique was very simple, and no narcotics were used. Although complaints of postoperative discomfort were high (approximately 30%), all were mild and relieved by non-narcotic oral analgesics.

TABLE 3. Effect of Postoperative Nausea and Vomiting on Discharge Time

	N	Discharge Time (min)
No nausea	51	119.8 $\pm$ 34.5
Nausea and vomiting	9	171.7 $\pm$ 27.4*

\*  $P < 0.05$ .

Nausea and vomiting was much less when nitrous oxide was omitted (3.2%) than when it was used (25%). Discharge time in patients with nausea and vomiting was significantly longer than in patients without these symptoms. Other authors<sup>13,14</sup> have recently reported this same finding. The incidence of nausea and vomiting was significantly decreased when nitrous oxide was omitted. Time to discharge tended to be longer in the nitrous oxide group, but this was not statistically significant. The reason for this is because, although the nitrous oxide group had a higher incidence of emetic symptoms, the majority of patients in this group were still symptom free. Although the discharge time between experimental groups was not different, we believe the decrease in nausea and vomiting was still important. If a patient who is not completely in control of his or her airway reflexes vomits, he or she may aspirate gastric contents. Protracted nausea and vomiting may lead to potential dehydration and be a reason for admission. Neither of these, however, occurred in our study. Emetic symptoms almost always make a patient uncomfortable. Another patient who views the vomiting patient may also feel uncomfortable. Patients who are uncomfortable may be unhappy with their surgeon, anesthesiologist, or the surgical facility. As outpatient facilities continue to increase in number, competition for patients will be keen. A facility in which patients are not happy will not do well. Even if no major complication occurs, it is important to prevent nausea and vomiting.

Several colleagues expressed to us a concern for possible patient awareness under anesthesia when nitrous oxide is omitted. Although the exact incidence is unknown, awareness during surgery has been reported with increasing frequency in recent years.<sup>15</sup> This awareness can be a distressing or even terrifying experience, which may result in psychiatric problems in the patient.<sup>16</sup> Our study was designed to inquire about intraoperative awareness. Although we cannot absolutely rule out awareness, no one reported any memories of any events between induction of anesthesia and awakening in the recovery room.

In summary, we found that eliminating nitrous oxide from isoflurane/oxygen anesthesia for minor outpa-

tient procedures in healthy women greatly decreases the amount of postoperative nausea and vomiting. The elimination of nitrous oxide does not appear to increase the risk of intraoperative awareness.

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