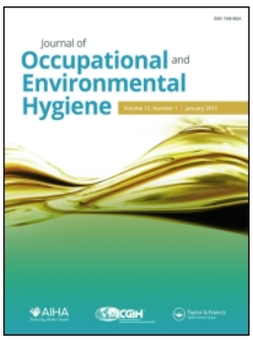

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Exposure control practices for administering nitrous oxide: A survey of dentists, dental hygienists, and dental assistants

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ABSTRACT

Engineering, administrative, and work practice controls have been recommended for many years to minimize exposure to nitrous oxide during dental procedures. To better understand the extent to which these exposure controls are used, the NIOSH Health and Safety Practices Survey of Healthcare Workers was conducted among members of professional practice organizations representing dentists, dental hygienists and dental assistants. The anonymous, modular, web-based survey was completed by 284 dental professionals in private practice who administered nitrous oxide to adult and/or pediatric patients in the seven days prior to the survey. Use of primary engineering controls (i.e., nasal scavenging mask and/or local exhaust ventilation (LEV) near the patient's mouth) was nearly universal, reported by 93% and 96% of respondents who administered to adult (A) and pediatric (P) patients, respectively. However, adherence to other recommended precautionary practices were lacking to varying degrees, and were essentially no different among those administering nitrous oxide to adult or pediatric patients. Examples of work practices which increase exposure risk, expressed as percent of respondents, included: not checking nitrous oxide equipment for leaks (41% A; 48% P); starting nitrous oxide gas flow before delivery mask or airway mask was applied to patient (13% A; 12% P); and not turning off nitrous oxide gas flow before turning off oxygen flow to the patient (8% A; 7% P). Absence of standard procedures to minimize worker exposure to nitrous oxide (13% of all respondents) and not being trained on safe handling and administration of nitrous oxide (3%) were examples of breaches of administrative controls which may also increase exposure risk. Successful management of nitrous oxide emissions should include properly fitted nasal scavenging masks, supplemental LEV (when nitrous oxide levels cannot be adequately controlled using nasal masks alone), adequate general ventilation, regular inspection of nitrous oxide delivery and scavenging equipment for leaks, availability of standard procedures to minimize exposure, periodic training, ambient air and exposure monitoring, and medical surveillance.

KEYWORDS

Dental anesthesia providers; exposure controls; nitrous oxide; web survey

Introduction

Nitrous oxide (with oxygen) is the most common inhaled anesthetic used in dentistry, used to control patient anxiety and pain. It is usually administered by dentists; however, in certain states licensed dental hygienists and dental assistants can administer nitrous oxide.[1,2] There are more than 650,000 dental professionals (i.e., dentists, dental hygienists, dental assistants) who practice dentistry in the U.S.[3] Available information shows that nitrous oxide is used by most (89%) dentists who provide care to pediatric patients and a majority (58%) of all dentists.[4–6]

Acute exposure to nitrous oxide may cause lightheadedness, eye and upper airway irritation, cough, shortness of breath, decreases in mental performance, and manual dexterity.[7,8] Chronic exposure to high levels of nitrous oxide among female dental assistants who worked in offices where scavenging equipment was not used was associated with an increased risk of spontaneous abortion, and reduced fertility.[9,10] Exposure to nitrous oxide has also been associated with an increased risk of neurologic, renal, and liver disease.[11,12]

Guidelines for minimizing healthcare worker exposure to nitrous oxide have been recommended by government

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agencies and professional practice organizations.[13–15] They are generally consistent with respect to primary prevention measures and application of a hierarchical approach for control technologies to mitigate workplace hazards.[16] This approach specifies that unless the hazard can be substituted by a substance less toxic or eliminated (e.g., oral or intravenous sedation), exposure controls should be systematically implemented in the following decreasing order of efficacy: engineering controls, administrative controls, work practice controls, and personal protective equipment (PPE). Examples of engineering controls include nasal scavenging masks and local exhaust ventilation (LEV) with the vent opening near the patient's mouth. Examples of administrative controls include training and education, exposure monitoring and medical surveillance. Examples of work practice controls include checking for leaks in gas lines and starting nitrous oxide flow after mask or airway device is applied to patient. Use of effective engineering, administrative and work practice controls would preclude the need for respiratory protection for nitrous oxide during dental procedures; however, other types of PPE would be needed to protect dental personnel from exposure to blood or other potentially infectious material.[17]

The primary objective of this study to examine the use of engineering, administrative controls and work practice controls during administration of nitrous oxide by dental professionals including dentists, dental hygienists and dental assistants. This survey is one of the first to examine adherence to precautionary practices by type of dental professional (dentist, dental hygienist, dental assistant) and patient (adult and pediatric).

Methods

Survey methodology

The Health and Safety Practices Survey of Healthcare Workers is an anonymous, modular, web-based survey conducted by the National Institute for Occupational Safety and Health (NIOSH) in early 2011. The study population included members of professional practice organizations representing healthcare occupations which routinely use or come in contact with selected hazardous chemicals and drugs. Practices around administration of anesthetic gases were addressed by one of seven hazard modules. Information on overall methods used in the development and testing of the survey instrument, survey design and functionality, survey population, survey implementation, respondent characteristics, and other information including strengths and limitations of the survey have been previously described.[18]

Study population and survey implementation

The study population for the module on administration of anesthetic gases was targeted to members of major professional practice organizations representing healthcare workers who administer anesthetic gases during medical and dental procedures. These included dentists, dental hygienists, and dental assistants, in addition to physician anesthesiologists, nurse anesthetists, and anesthesiologist assistants which are reported elsewhere.[19] These professional organizations invited members via email which included a hyperlink to the survey.

Survey instrument

The web survey included a screening module, core module, and seven hazard modules. If the respondent indicated in the screening module that they had administered anesthetic gases in the past week, they were eligible for the anesthetic gases module. The modular survey was programmed to sequentially present, based on screening questions, the most relevant hazard module, the core module, and a second hazard module, if indicated. Respondents were not presented with more than two hazard modules.

The anesthetic gases module contained 24 questions targeted to dental anesthesia providers. The format of the questions included multiple choice, Likert scale options, multi-part, yes/no, and numeric. For a few questions where response options were not exhaustive, respondents could mark "other" and type in a response. These were reviewed and determined if they (a) fit into one of the existing categories, (b) were valid other responses, or (c) were unrelated to the question, i.e., general notes about the survey. Responses were recoded, or left as "other" in the case of (b), to reflect this determination.

Most questions sought information for the seven days prior to the survey (hereafter referred to as the past week). Topic areas and content of key practice questions are presented in Table 1. The same questions on exposure controls and precautionary practices were asked separately of respondents who administered nitrous oxide to adult patients (≥13 years of age) and pediatric patients (≤12 years of age), to determine whether there were any differences in the use of exposure controls and other precautionary practices.

Data analysis

Data were analyzed using SAS 9.3 (SAS Institute, Inc., Cary, NC). Simple frequencies and prevalences are presented. Stratification was used to further describe aspects of the use of engineering controls (e.g., use of either

Table 1. Survey instrument topic areas and content of questions.

Topic Area
Training
Frequency (within the past 12 months, more than 12 months ago, never)
Employer procedures
Availability of employer standard procedures to minimize exposure to nitrous oxide
Administration practices
Number of days administering nitrous oxide in the past 7
Patient receiving nitrous oxide[a]
adult (non-pediatric)[b]
pediatric[b]
Engineering controls
Frequency[c] of use of patient nasal scavenging mask[a]
Frequency[c] of use of a local exhaust ventilation (LEV) near to patient's mouth
Precautionary work practices—frequency[c] of activity[a]
Check nitrous oxide delivery equipment for leaks
Start nitrous oxide flow after nasal mask was applied to patient
Stop nitrous oxide flow before turning off carrier gas to breathing system
Personal and environmental monitoring practices for nitrous oxide
Personal exposure monitoring in past 12 months

[a] Asked separately for pediatric and adult (non-pediatric) patients.
[b] Adult (non-pediatric) patient was defined as ≥13 years of age; pediatric patient was defined as ≤12 years of age.
[c] Response options included: every time, most times, sometimes, rarely, never. Depending on the question, an additional response option may have been be included: device not available, not available, not applicable, system not available.

patient nasal scavenging mask or LEV, combined use of these controls) and patient type (adult and/or pediatric). Because most respondents were in private practice (96%) and only used nitrous oxide (98%), analyses excluded respondents in other types of ownership (i.e., non-profits, public sector) and those reported using other inhaled anesthetics (e.g., sevoflurane). Because of the relatively low number of dental assistants who participated in the survey (n = 20) the data for this occupation were combined with the data for dental hygienists (n = 92). Results include responses to selected questions in the core module that describe demographic, employer, and occupation characteristics. This survey was developed to provide descriptive information on practices around administration of nitrous oxide. No *a priori* hypotheses were proposed therefore statistical tests were not done.

Institutional review board

The NIOSH Institutional Review Board determined that the activities in this project were surveillance and did not meet the criteria of research according to 45 CFR 46.1101(b)(2) and CDC Guidelines for Defining Public Health Research and Public Health Non-Research.[20]

Results

Respondent characteristics

Respondent demographic and employer characteristics are presented in Table 2. Two hundred eighty-four respondents, including 172 dentists and 112 dental hygienists and dental assistants in private practices completed the hazard module addressing anesthetic gases. The main practice of dentists included general dentists (72%), pediatric dentists (14%), oral and maxillofacial surgeons (6%), periodontists (5%), and endodontists and prosthodontists (3% each). Collectively, dentists were best characterized as follows: mean age of 51 years (range: 28–65 years), male (77%), white (94%), all had doctoral or post doctoral degrees, and 61% worked in their profession—57% for their current employer—for more than 20 years. Nearly half (46%) of the dental practices were located in large cities, and equally distributed across four U.S. Census regions with exception of the Northeast where representation was comparatively less.

Nearly all dental hygienists/assistants were white females, with a mean age of 46 years (range: 21–63 years). Most (95%) possessed Associate's or Bachelor's degrees. Half worked in their profession for more than 20 years and nearly half (48%) worked for their same employer for 5 years or less. Nearly three-quarters (73%) of the dental offices where they worked were located in the West and Midwest. In general, sex, ethnicity, age distribution, education, time in profession, and with current employer were markedly different among dentists and dental hygienists/assistants.

Nitrous oxide administration practices of dentists and dental hygienists/assistants are presented in Table 3. Among dentists, 60% administered nitrous oxide for >20 years; over half (55%) administered for 2 or fewer days of the past 7; most (87%) administered to adult patients and more than half (54%) to pediatric patients, while 41% administered to both patient types. Administration practices among dental hygienists/assistants were markedly different from dentists. Over a third (39%) administered nitrous oxide for five or fewer years; most (82%) administered for two or fewer days in the past seven, most (94%) administered to adult patients and less than a fifth (18%) to pediatric patients, while only 12% administered to both.

Administrative controls

Training and standard procedures

Training on the safe handling of nitrous oxide was nearly universal among respondents. Nearly all (98%) dentists and most (94%) dental hygienists/assistants reported that they had received training (Table 4). However, most dentists (85%) and dental hygienists/assistants (63%) reported that the training was more than 12 months ago.

Table 2. Respondent characteristics.

Characteristic	All Dental Anesthesia Providers (n[a]) Percent[b]	Dentists (n[a]) Percent[b]	Dental Hygienists/Assistants (n[a]) Percent[b]
Sex	(280)	(171)	(109)
Male	48	77	2
Female	53	23	98
Race[c]	(277)	(168)	(109)
White	95	94	97
Black	0	0	0
Asian	4	6	2
Other	1	1	1
Ethnicity	(279)	(170)	(109)
Hispanic	3	1	6
Age (years)	(278)	(169)	(109)
20–24	1	0	2
25–34	18	14	24
35–44	14	15	12
45–54	27	22	34
55–64	38	44	28
>64	3	5	0
Education	(280)	(171)	(109)
≤Associate's degree	20	0	50
Bachelor's degree	18	0	45
Master's degree	1	0	4
Doctoral degree/Plus	61	100	1
Time in Current Occupation	(284)	(172)	(112)
<1 year	5	0	13
1–5 years	14	13	14
6–10 years	10	10	9
11–20 years	14	15	13
21–30 years	25	27	23
>30 years	31	34	27
Time with Current Employer	(283)	(171)	(112)
<1 year	8	2	18
1–5 years	22	16	30
6–10 years	13	11	15
11–20 years	17	14	22
>20 years	40	57	14
Member of a Labor Union	(280)	(171)	(109)
Yes	1	1	1
Size of Employer (number of employees)	(284)	(172)	(112)
1 (i.e., only myself)	<1	1	0
2–9	67	67	67
10–99	32	32	33
100–249	<1	1	0
250–1,000	0	0	0
>1,000	0	0	0
Employer Regional Location[d]	(280)	(169)	(111)
Northeast	12	14	8
Midwest	30	30	32
South	25	29	20
West	33	27	41
Employer Location by Population Density	(283)	(172)	(111)
Large city (≥ 50,000 people)	44	46	41
Small city (< 50,000 people)	22	23	20
Suburbs	22	21	24
Rural areas (e.g., farms, ranches, small towns, and unpopulated regions)	12	10	15

[a]Number of respondents varied for individual items (i.e., number of eligible respondents less number who elected not to answer).
[b]Percents may not add up to exactly 100% due to rounding.
[c]Percents may add to more than 100% because respondents could select more than one answer.
[d]Northeast: Connecticut, Maine, Massachusetts, New Jersey, New Hampshire, New York, Pennsylvania, Rhode Island, and Vermont; Midwest: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin; South: Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia; West: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

Most (93%) dentists reported that standard procedures to minimize exposure to nitrous oxide were available (Table 4). By contrast, only two-thirds (66%) of dental hygienists/assistants reported the same, with a third (34%) reporting that they did not have procedures or did not know whether they had them or not.

Exposure monitoring

Less than one tenth of dentists (9%) and dental hygienists/assistants (7%) reported that exposure monitoring had been conducted in the past 12 months to assess workers' exposure to nitrous oxide (Table 4). A greater proportion of dental hygienists/assistants as compared to

Table 3. Nitrous oxide administration practices of respondents.

Administration Practices (in the past 7 calendar days unless otherwise noted)	All Dental Anesthesia Providers (n[a]) Percent	Dentists (n[a]) Percent[b]	Dental Hygienists/Assistants (n[a]) Percent[b]
No. of years (in career) administering nitrous oxide	(284)	(172)	(112)
< 1 year	4	1	8
1–5 years	20	13	31
6–10 years	13	12	14
11–20 years	15	15	17
> 20 years	48	60	29
No. of days administering nitrous oxide	(284)	(172)	(112)
1 day	45	34	61
2 days	21	21	21
3 days	15	19	10
4 days	13	17	8
5 days	5	8	1
6–7 days	1	1	0
Administered nitrous oxide to patients 13 years or older (i.e., adult or non-pediatric patients)	(284)	(172)	(112)
Yes	90	87	94
Administered nitrous oxide to patients 12 years or younger (i.e., pediatric patients)	(284)	(172)	(112)
Yes	40	54	18
Administered nitrous oxide to adult and pediatric patients	(284)	(172)	(112)
Yes	30	41	12

[a]Number of respondents varied for individual items (i.e., number of eligible respondents less number who elected not to answer).
[b]Percents may not add up to exactly 100% due to rounding.

dentists (17% vs. 5%) were unsure whether monitoring had been conducted.

Engineering controls

Respondents were asked how often (i.e., every time, most times, sometimes, rarely, never) they used a patient nasal scavenging mask and/or LEV near the patients' mouth when administering nitrous oxide to adult and pediatric patients. The percent of respondents who used either a patient nasal mask or LEV "every time" was nearly universal for adult patients (93%, n = 255) and pediatric patients (96%, n = 113) (Table 5). The proportion of dentists using either control was the same (95%) for both patient types; however, for dental hygienists/assistants the proportion was higher for pediatric vs. adult patients (100%, n = 20 vs. 90%, n = 105, respectively). Nasal scavenging masks were the preferred method of controlling waste nitrous oxide at the patient, used by 91% of respondents for adult patients and 96% of respondents for pediatric patients. On average, LEV was used "every time" by only 22% of respondents (both patient types). LEV was used by a greater proportion of dental hygienists/assistants compared to dentists, and more so for

Table 4. Administrative controls: training, standard procedures, and exposure monitoring.

Training, Standard Procedures, and Exposure Monitoring	All Dental Anesthesia Providers (n[a]) Percent	Dentists (n[a]) Percent[b]	Dental Hygienists/Assistants (n[a]) Percent[b]
Received training on safe handling of anesthetic gases[c]	(283)	(171)	(112)
Yes, within the past 12 months	20	13	30
Yes, more than 12 months ago	77	85	63
Never	3	1	6
Employer has standard procedures to minimize worker exposure during administration of anesthetic gases[c]	(283)	(171)	(112)
Yes	82	93	66
No	13	5	24
I don't know	5	2	10
Exposure monitoring was conducted in the past 12 months to assess workers' exposure to anesthetic gases[c]	(284)	(172)	(112)
Yes	8	9	7
No	82	85	76
I don't know	10	5	17

[a]Number of respondents varied for individual items (i.e., number of eligible respondents less number who elected not to answer).
[b]Percents may not add up to exactly 100 percent due to rounding.
[c]Refers only to nitrous oxide; a small percentage of respondents who administered other anesthetics were excluded from the analysis (see Data Analysis).

TABLE 5. Engineering and work practice controls for administering nitrous oxide to adult and pediatric patients.

	Adult Patients			Pediatric Patients		
Type of Exposure Control	All Dental Anesthesia Providers	Dentists	Dental Hygienists/ Assistants	All Dental Anesthesia Providers	Dentists	Dental Hygienists/ Assistants
Engineering Controls	Every Time [a] ([n][b]) Percent	Every Time [a] ([n][b]) Percent	Every Time [a] ([n][b]) Percent	Every Time [a] ([n][b]) Percent	Every Time [a] ([n][b]) Percent	Every Time [a] ([n][b]) Percent
When administering nitrous oxide to patients during the past 7 calendar days, how often did you …						
1) always use either a patient nasal scavenging mask or LEV near the patient's mouth?	(255) 93	(150) 95	(105) 90	(113) 96	(93) 95	(20) 100
2) always use a patient nasal scavenging mask regardless of LEV use?	(255) 91	(150) 94	(105) 87	(113) 96	(93) 95	(20) 100
3) always use LEV near the patient's mouth regardless of patient nasal mask use?	(255) 22	(150) 19	(105) 27	(113) 22	(93) 16	(20) 50
4) always use both a patient nasal scavenging mask and LEV near the patient's mouth?	(255) 21	(150) 19	(105) 24	(113) 22	(93) 16	(20) 50
Work Practice Controls [c]	Every Time/ Most Times [a] ([n][b]) Percent	Every Time/ Most Times [a] ([n][b]) Percent	Every Time/ Most Times [a] ([n][b]) Percent	Every Time/ Most Times [a] ([n][b]) Percent	Every Time/ Most Times [a] ([n][b]) Percent	Every Time/ Most Times [a] ([n][b]) Percent
When administering nitrous oxide to patients during the past 7 calendar days, how often did you …						
1) check delivery system for leaks?	(217) 59	(135) 57	(82) 63	(102) 52	(86) 50	(16) 63
2) start nitrous oxide flow after nasal mask was placed on the patient?	(246) 87	(148) 84	(98) 90	(110) 88	(93) 87	(17) 94
3) turn off nitrous oxide flow before oxygen shut off?	(246) 92	(148) 94	(98) 90	(112) 93	(93) 95	(19) 84

LEV = local exhaust ventilation.
[a]Respondents were asked to select from the following response options: every time, most times, sometimes, rarely, or never. Some of the questions included "not available" or "not applicable" as additional response options.
[b]Total number of respondents varies for individual items (i.e., number of eligible respondents less number who elected not to answer).
[c]Excludes respondents who reported "not applicable" (i.e., others were responsible for this work practice).

pediatric patients. About a fifth of respondents reported using a patient nasal scavenging mask in combination with LEV (both patient types).

Respondents were asked whether they spent time with recovering patients and, if so, whether the general ventilation in the recovery area was adequate. Half (50%, n = 170) of dentists and a quarter (24%, n = 111) of dental hygienists/assistants reported that they spent some time with patients while they recovered from anesthesia. Most dentists (88%, n = 85) and dental hygienists/assistants (70%, n = 27) indicated that the recovery area was adequately ventilated; however, a greater proportion of dental hygienists/assistants (26%) vs. dentists (8%) did not know.

Work practice controls

Respondents were asked how often (same frequency scale described above) the following work practices were used when administering nitrous oxide to adult and pediatric patients: checking nitrous oxide delivery system for leaks (practice #1), starting nitrous oxide flow after delivery mask or airway mask was applied to patient (practice #2), and turning off nitrous oxide flow before oxygen flow (practice #3) (Table 5). Adherence to these practices was evaluated by combining the percent of respondents performing each practice "every time" and "most times." Overall, adherence was greatest with respect to practice #3 and least with respect to practice #1.

Discussion

The primary objective of this national survey was to examine the extent of use of engineering, administrative and work practice controls during administration of nitrous oxide by dental anesthesia providers in the U.S. In addition to dentists, respondents included dental hygienists and dental assistants which makes this one of a few studies that addresses nitrous oxide exposure control practices among these two occupational groups. This study focused on the majority of respondents—those who worked in private practices and solely administered nitrous oxide.

Nasal scavenging masks, general (dilution) ventilation, and supplemental LEV near the patient's mouth represent longstanding recommendations from professional groups and governmental agencies.[13–15] In this web-based survey, we found that the use of engineering controls (i.e., nasal scavenging mask and/or LEV near the patient's mouth) was nearly universal, reported by 93% and 96% of respondents who administered to adult and pediatric patients, respectively. Nasal masks were the primary means of removing waste nitrous oxide,

reported by 91% and 96% of respondents who administered to adult and pediatric patients, respectively, and markedly higher than reported (57–62%) in previous studies.[21,22] The combined use of nasal masks and LEV, although not common, is preferred; the latter would remove nitrous oxide from the patient's open mouth (perhaps the largest single source of nitrous oxide in the operatory) in addition to any leaks from the nasal mask, especially if not properly fitted or dealing with an uncooperative pediatric patient. With respect to dilution ventilation, most respondents who spent time with patients after the procedure stated that the room (i.e., operatory room or recovery room) where patients recovered from anesthesia was adequately ventilated.

With respect to administrative controls (i.e., training, standard procedures, exposure monitoring), we found that most respondents (97%) had received training addressing safe handling of nitrous oxide; however, three-quarters (77%) reported that the training was more than a year ago. The availability of standard procedures to minimize nitrous oxide exposures was more often reported by dentists (93%) than dental hygienists/assistants (66%). Training and education are fundamental administrative controls, recommended upon initial job assignment or whenever a new chemical or process is introduced.[23] Although not required, annual training and availability of standard procedures would increase the likelihood that precautionary measures would become second nature among all dental anesthesia providers who are potentially exposed to nitrous oxide. While exposure monitoring was not a common practice, periodic monitoring for nitrous oxide is recommended by NIOSH and OSHA as a means of assessing the effectiveness of exposure controls.

With respect to work practices, we found that leak checks of the nitrous oxide delivery equipment were performed by only half of respondents. There was much better adherence to the other work practices (i.e., starting nitrous oxide flow after applying patient nasal mask and shutting off nitrous oxide flow before oxygen was shut off). Checking for leaks and judicious starting/stopping of nitrous oxide flows are recommended practices that should always be followed to minimize exposure to waste nitrous oxide. Implementation of these and other best work practices is essential to maximize the utility of scavenging systems to reduce waste and exhaled nitrous oxide to the lowest possible levels.[24]

Several limitations apply to this survey which was a targeted, voluntary sample and may not be generalizable to the larger population of dental professionals who administer nitrous oxide. Adherence to recommended precautionary practices may be higher for survey participants than the general population of dental anesthesia providers. As members of professional practice organizations survey participants may be more aware of health and safety issues than their non-member counterparts. Survey data are self-reported and not validated by observation or other means. For example, reporting that the general ventilation was "adequate" was a subjective determination which would need to be validated by determining the number of room air changes per hour and comparing the value to recommended guidelines.[25,26] Finally, the relatively small number of dental assistants participating in the survey precluded presentation of findings specific to this occupation.

Information on the effectiveness of nasal scavenging masks, LEV and general ventilation, and availability of, and participation in, a medical surveillance program, was not collected in this study and should be evaluated in future studies.

Conclusions

This is one of the first national surveys to examine use of engineering, administrative, and work practice controls during administration of nitrous oxide by type of dental anesthesia provider and patient. Findings from this survey show nearly universal use of primary engineering controls during administration of nitrous oxide to adult and pediatric patients. However, other precautionary practices were lacking which may potentially expose dental anesthesia providers to nitrous oxide. Successful management of nitrous oxide emissions should include properly fitted nasal scavenging masks, supplementary LEV (when nitrous oxide levels cannot be adequately controlled using nasal masks alone), adequate general ventilation, regular inspection of nitrous oxide delivery and scavenging equipment for leaks, availability of standard procedures to minimize exposure, periodic training, ambient air and exposure monitoring, and medical surveillance.

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