New York University
Interdepartmental Communication

DATE: April 03, 2006

TO: Glenn Marrus
Dental Center-Assistant Dean for Quality Assurance

FROM: Justin K Wilson
Environmental Services

SUBJECT: Monitoring Results of Nitrous Oxide in the Pediatric Clinic at the Dental Center [DC]

Monitoring was performed for the DC pediatric clinic to determine air concentration of nitrous oxide [N2O] during operatory procedures. Attached is the final report of the monitoring. A total of three samples were taken for an 8-hour Time Weighted Average (TWA). The air concentration for the 8-hr. TWA of Nitrous Oxide ranged from 8.02 ppm to 30.63 ppm. The results were below the American Conference of Governmental Industrial Hygienist [ACGIH] threshold limit value of 50 ppm and one sample was above the National Institute of Occupational Safety and Health [NIOSH] recommended TWA exposure limit of 25 ppm. The data suggests that there may be some exposure to N2O during operatory procedures due to work practice.

If you have any questions, please call me at ext: 81440.

cc: Lou Ortiz

The operator wore safety glasses with side shields, latex gloves, scrubs, surgical mask with elastic ear bands and a lab coat. The anesthesiologist donned the same personal protective equipment excluding the surgical mask.

The mobile tank unit was brought into the operatory prior to use. A scavenging mask with nosepiece was attached to the tank unit. The nosepiece placed on the patient about 10 minutes prior to beginning the dental procedure.

During the procedure, the patient was shouting and crying. Due to this, the breathing cup was constantly being dismounted from the face of the patient, which may have contributed to employee exposure.

METHODS

Personal and area monitoring was performed for N2O by using Assay Technology Nitrous Oxide monitors (Model #X575 AT). A total of three samples were obtained for N2O. The samples were taken for the duration of the dental process, which was approximately 70 minutes minutes. The results in ppm were multiplied by the sampling time and divided by 480 minutes to calculate the 8-hr. TWA exposure level for each of the samples.

The monitors were shipped to Assay Technologies in Pleasanton, California to be analyzed using a simulated OSHA method #166 for Nitrous Oxide.

RESULTS AND CONCLUSION

The results of the monitoring are presented in Table 1. The results show that the concentration for N20 ranged from 8.20 ppm to 30.63 ppm. All results were below the ACGIH recommendation of 50 ppm for an 8-hour TWA. One sample was found to be above the NIOSH recommendation of 25 ppm.

Table 1. Monitoring Results For Nitrous Oxide

Sample Date	Employee/ Area Monitored	Results	ACGIH [TLV]	NIOSH [REL]
2/28/06	[redacted]	30.63 ppm	50 ppm	25 ppm
	[redacted]	8.02 ppm	50 ppm	25 ppm
	N2O Tank Unit	10.21 ppm	50 ppm	25 ppm

The Limit of Detection for N2O using the AT Organic Vapor Monitors (Method: Simulated OSHA #166) was 0.3 ppm.

RECOMMENDATIONS

All equipment must be checked for leakage before any procedures. Check all rubber hoses, connections, tubing, and breathing bags. Replace items when damaged or when recommended by the manufacturer. Perform leak testing of the equipment by using a soap solution to check for bubbles at high-pressure connections. Check both high-and low-pressure connections (such as O-rings) regularly, as they may become worn. Replace tank equipment periodically according to the manufacturer's recommendations.

This data suggest that there may be some exposure to N2O during operatory procedures due to work practice. Even though the 8-hour TWA's were low, the exposure experienced over the 70 minute duration of the procedure is of some concern. We should perform more testing to verify these results as well as explore possible engineering or administrative options that will reduce employee exposure.

Nitrous Oxide Monitoring Report
New York University (NYU) Dental Center
6/29/07

INTRODUCTION

On June 29, 2007, Environmental Health & Safety (EH&S) conducted personal and area monitoring for Nitrous Oxide [N2O] in the Dental Center Pediatric Clinic located on the 9th floor of the Weissman building. The monitoring was performed to determine air concentrations of N2O during operatory procedures on children. This survey was conducted in the Pediatric Clinic's "quiet room".

HEALTH HAZARD INFORMATION

Nitrous Oxide (CAS no. 10024-97-2) is a colorless gas with a slightly sweet odor that is used as an inhalation anesthetic. Concentrations of Nitrous Oxide over 50 parts per million (ppm) has been shown to reduce dexterity, cognition, motor and audiovisual skills [Ellenhorn et al. 1997, NIOSH 1977b]. Toxicity is usually due to asphyxia and not the chemical itself. Contact with the gas or liquefied gas may result in burns, severe injury and/or frostbite. An epidemiological study of workers [Rowland et al. 1992] and experimental animal evidence [Corbett et al. 1973, Vieira et al. 1980, 1983] indicates that occupational exposure may produce adverse reproductive effects [e.g., reduced fertility, spontaneous abortion].

REGULATIONS/GUIDELINES

The American Conference of Governmental Industrial Hygienist [ACGIH] has established a threshold limit value [TLV] for N2O at 50 ppm as a guideline for an 8-hour time weighted average [TWA] determined to protect the worker from decreases in perceptual, cognitive, motor skills and prevent embryofetal toxicity. The National Institute of Occupational Safety and Health [NIOSH] established a 25 ppm recommended exposure limit [REL] in order to prevent decreases in mental performance, audiovisual ability, and manual dexterity during workplace exposures to N2O.

OBSERVATIONS

On 6/29/07, personal monitors were placed on the lapels for both the operating dentist and the dental hygienist who performed the procedure on the day of the survey. In addition an area sample was collected on the regulator of the N2O and Oxygen mobile tank manifold.

The operating dentist wore safety glasses with side shields, latex gloves, scrubs, and surgical mask with elastic ear bands. The dental hygienist donned the same personal protective equipment with the addition of a lab coat.

The mobile tank unit was brought into the operatory roughly 30 minutes prior to use. A nosepiece mask was attached to the tank unit. The nosepiece placed on the patient about 10 minutes prior to beginning the dental procedure in order to get the patient comfortable. The patient was relatively calm in relation to past patients that have undergone the same procedure.

The child was moving around only slightly while the N2O and oxygen mixture was being administered to him. The operating dentist, the dental hygienist, and the patient's mother were all in the room at the time of the procedure.

METHODS

Personal and area monitoring was performed for N2O by using Assay Technology Nitrous Oxide monitors (Model #X575 AT). A total of three samples were obtained for N2O. The samples were taken for the duration of the dental process, which lasted just over an hour. The results in ppm were the total concentrations collected during the hour long procedure. There is no Time Weighted Average (TWA) calculation for N2O.

The monitors were shipped to Assay Technologies in Pleasanton, California to be analyzed using a simulated OSHA method #166 for Nitrous Oxide.

RESULTS AND CONCLUSION

The results of the monitoring are presented in Table 1. Visual inspection of the results shows the concentration for N20 was 59 ppm for the operating dentist, 71 ppm for the dental hygienist, and 67 ppm for the N2O tanks. On the survey date the operating dentist, dental hygienist, and the area sample collected on the tank manifold were all above both the NIOSH recommended limit of 25 ppm and the ACGIH threshold limit value of 50 ppm.

This data suggest that there may be significant exposure to N2O during operatory procedures due to work practice. The area sample collected on the tank manifold system suggests that there may be some leakage from the regulator and/or manifold system. However the results found for the operating dentist and dental hygienist were only slightly lower than the area sample collected. One possible cause is inadequate ventilation in the quiet room. The quiet room is a small enclosed room where young patients usually can feel more comfortable during dental procedures. However the size and possible inadequate ventilation of this room may increase the concentrations of N2O during dental procedures.

Table 1. Monitoring Results for Nitrous Oxide

Sample Date	Employee/ Area Monitored	Results	ACGIH [TLV]	NIOSH [REL]
06/29/07	[redacted] [Operating dentist]	59 ppm	50 ppm	25 ppm
	[redacted] [dental hygienist]	71 ppm		
	N2O Tank Unit	67 ppm		

The Limit of Detection for N2O using the AT Organic Vapor Monitors (Method: Simulated OSHA #166) was 0.3 ppm.

RECOMMENDATIONS

All equipment must be checked for leakage before any procedures. Check all rubber hoses, connections, tubing, and breathing bags. Replace items when damaged or when recommended by the manufacturer. Perform leak testing of the equipment by using a soap solution to check for bubbles at high-pressure connections. Check both high-and low-pressure connections (such as O-rings) regularly, as they may become worn. Replace tank equipment periodically according to the manufacturer's recommendations.

A set of work practices must be established to prevent excess nitrous oxide in the operatory. Supply scavenging masks in a variety of sizes so that the mask always fits comfortably and securely over the patient's nose or face. When dealing with children, use an immobilizer for the head in addition to the Velcro body wrap for patients or procedures that may be more difficult. Consider increasing general ventilation in the quiet room especially during dental procedures. A local ventilation system may also be helpful in reducing fugitive N2O exposure in the quiet room. It is important to conduct a follow up exposure survey in the general clinic area where ventilation characteristics are different as well as repeating the exposure survey in the quiet room again. Training for Nitrous Oxide exposure should also be considered in order to inform employees about their potential exposure while working within the Pediatric clinic.

REFERENCES

Corbett TH, Cornell RG, Endres JL, Millard RI [1973]. Effects of Low Concentrations of Nitrous Oxide on Rat Pregnancy. Anesthesiology 39:299B301.

Ellenhorn, M.J., S. Schonwald, G. Ordog, J. Wasserberger. Ellenhorn's Medical Toxicology: Diagnosis and Treatment of Human Poisoning. 2nd ed. Baltimore, MD: Williams and Wilkins, 1997. 1495

NIOSH [1977b]. Criteria for a Recommended Standard: Occupational Exposure to Waste Anesthetic Gases and Vapors. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 77B140.

Rowland AS, Baird DD, Weinberg CR, Shore DL, Shy CM, Wilcox AJ [1992]. Reduced Fertility Among Women Employed as Dental Assistants Exposed to High Levels of Nitrous Oxide. New Eng J Med 327(14):993B997.

Vieira E, Cleaton-Jones JP, Austin JC, Moyes DG, Shaw R [1980]. Effects of Low Concentrations of Nitrous Oxide on Rat Fetuses. Anesth and Analgesia 59(3):175B177.

Vieira E, Cleaton-Jones P, Moyes D [1983]. Effects of Low Intermittent Concentrations of Nitrous Oxide on the Developing Rat Fetus. Br J Anaesth 55:67B69.

Nitrous Oxide Monitoring Report
New York University (NYU) Dental Center
3/27/08 follow up on 4/22/08 & 4/23/08

INTRODUCTION

Environmental Health & Safety (EH&S), periodically performs air monitoring to determine potential exposure to nitrous oxide. On March 27, 2008, EH&S conducted personal and area monitoring for Nitrous Oxide [N2O] in the Dental Center Pediatric Clinic located on the 9th floor of the Weissman building. The monitoring was performed to determine potential exposure to N2O during operatory procedures on children. This survey was conducted in the Pediatric Clinic's "quiet room" and an operatory in the open area of the clinic. Follow up surveys were conducted in the same locations on April 22 and 23, 2008 in order to verify if work procedure changes were effective in reducing N2O levels. On May 15 and 19, 2008 a direct reading instrument was utilized to collect instantaneous N2O levels around the N2O delivery and scavenging system in use in an effort to pin point leaks in the system.

HEALTH HAZARD INFORMATION

Nitrous Oxide (CAS no. 10024-97-2) is a colorless gas with a slightly sweet odor that is used as an inhalation anesthetic. Concentrations of Nitrous Oxide over 50 parts per million (ppm) has been shown to reduce dexterity, cognition, motor and audiovisual skills [Ellenhorn et al. 1997, NIOSH 1977b]. Toxicity is usually due to asphyxia and not the chemical itself. Contact with the gas or liquefied gas may result in burns, severe injury and/or frostbite. An epidemiological study of workers [Rowland et al. 1992] and experimental animal evidence [Corbett et al. 1973, Vieira et al. 1980, 1983] indicates that occupational exposure may produce adverse reproductive effects [e.g., reduced fertility, spontaneous abortion].

REGULATIONS/GUIDELINES

The American Conference of Governmental Industrial Hygienist [ACGIH](updated 2003) has established a threshold limit value [TLV] for N2O at 50 ppm as a guideline for an 8-hour time weighted average [TWA] determined to protect the worker from decreases in perceptual, cognitive, motor skills and prevent embryofetal toxicity. The National Institute of Occupational Safety and Health [NIOSH](established in 1977) established a 25 ppm recommended exposure limit [REL] in order to prevent decreases in mental performance, audiovisual ability, and manual dexterity during workplace exposures to N2O. The Occupational Safety and Health Administration [OSHA] does not have regulatory standards for N2O.

MONITORING & OBSERVATIONS

3/27/08

On 3/27/08, personal monitors were placed on the lapels for both the operating dentist and the dental hygienist who performed the procedures in the open operatory on the day of the survey. In addition an area sample was collected on the regulator of the N2O and Oxygen mobile tank manifold. In the "quiet room" only the dentist and area sample on the tank were tested. Two operatory procedures were sampled for on 3/27/08: one in the "quiet room" and one in the open clinic area.

The operating dentists wore latex gloves, scrubs, and surgical masks with splash guards covering their eyes. The dental hygienists donned the same personal protective equipment with the addition of a lab coat.

For the procedure that took place in the open area of the clinic, the dental chair was located a few feet from the window. The window was opened about 6 inches for the duration of the procedure. The mobile tank unit was brought into the operatory roughly 10 minutes prior to use. A nosepiece mask was attached to the tank unit. The nosepiece was placed on the patient prior to beginning the dental procedure in order to get the patient comfortable. The patient was very calm and still during the procedure. There were minimal pre checks on the N2O and Oxygen tanks observed before the procedure took place. [redacted] was the Resident Dentist and [redacted] was the Dental Assistant during this procedure.

For the procedure that took place in the "quiet room" a window was adjacent to the dental chair however the window was only an inch or two open during the procedure. The mobile tank unit was brought into the operatory roughly 10 minutes prior to use. The patient was uncomfortable and upset from the start of the procedure. The nose piece was placed on the patient's nose in order to calm him during the procedure. However the patient was crying and screaming throughout the administering of the N2O. The dental resident increased the flow of N2O in an attempt to calm the patient. The nose piece was held over the patient's mouth at one point in an effort to administer the N2O more directly. When the nose piece was placed on the patient's nose it would quickly become dislodged. Half way through the procedure the N2O and Oxygen was turned off because it was having little to no effect on the patient. During the procedure additional personnel were moving in and out of the "quite room' assisting and observing. The door was kept closed throughout the procedure. [redacted] was the Resident Dentist during this procedure. Insufficient numbers of N2O exposure badges left this sampling session without a Dental Assistant sample.

See Tables 1 and 2 for results on page 7.

4/22/08

Since the N2O delivery equipment was not leak tested and the 3/27/08 results were high, monitoring was redone on April 22 and 23, 2008. On 4/22/08, personal monitors were placed on the lapels for both the operating dentist and the dental hygienist who performed the procedures on the day of the survey. In addition an area sample was collected on the regulator of the N2O and Oxygen mobile tank manifold. Two operatory procedures were sampled for on 4/22/08: one in the "quiet room" and one in the open clinic area.

The operating dentists wore latex gloves, scrubs, and surgical masks with splash guards covering their eyes. The dental hygienists donned the same personal protective equipment with the addition of a lab coat.

Prior to both procedures the N2O/Oxygen tank manifold was leak tested.

For the procedure that took place in the open area of the clinic, the dental chair was located a few feet from the window. The window was opened about 6 inches for the duration of the procedure. The mobile tank unit was brought into the operatory roughly 10 minutes prior to use. A nosepiece mask was attached to the tank unit. The nosepiece was placed on the patient prior to beginning the dental procedure in order to get the patient comfortable. The patient was crying during the procedure dislodging the nose piece from her nose. The dental resident would re adjust the nose piece every time it was dislodged. [redacted] was the Resident Dentist and [redacted] was the Dental Assistant during this procedure.

For the procedure that took place in the "quiet room" a window was adjacent to the dental chair however the window was only an inch or two open during the procedure. The mobile tank unit was brought into the operatory roughly 10 minutes prior to use. The patient was generally calm and made only minor movements during the procedure. It was observed that the scavenging system was turned on about 5 minutes after N2O had already been administered to the patient. The door was kept closed throughout the procedure. [redacted] was the Resident Dentist and [redacted] was the Dental Assistant during this procedure.

See Tables 3 and 4 for results on page 8.

4/23/08

On 4/23/08, personal monitors were placed on the lapels for both the operating dentist and the dental hygienist who performed the procedures on the day of the survey. There were not enough dosimeter badges to collect area samples during this day of sampling in the Pediatric Clinic. Two operatory procedures were sampled for on 4/23/08: one in the "quiet room" and one in the open clinic area.

The operating dentists wore latex gloves, scrubs, and surgical masks with splash guards covering their eyes. The dental hygienists donned the same personal protective equipment with the addition of a lab coat.

Prior to both procedures the N2O/Oxygen tank manifold was leak tested.

For the procedure that took place in the open area of the clinic, the dental chair was located a few feet from the window. The window was opened about 18 inches for the duration of the procedure. The mobile tank unit was brought into the operatory roughly 10 minutes prior to use. A nosepiece mask was attached to the tank unit. The nosepiece was placed on the patient prior to beginning the dental procedure in order to get the patient comfortable. Kinks were found in the tubing before N2O was administered but were corrected prior to applying N2O to the patient. The patient was calm and made only minor movements during the procedure. [redacted] was the Resident Dentist and [redacted] was the Dental Assistant during this procedure.

For the procedure that took place in the "quiet room" a window was adjacent to the dental chair however the window was only an inch or two open during the procedure. The mobile tank unit was brought into the operatory roughly 10 minutes prior to use. The patient was generally calm but half way through the procedure started to move. Another resident in the room held down the patient's head in order to immobilize the patient. Ten minutes into the procedure it was observed that a secondary regulator valve for the scavenging system was not turned on. The dental assistant was informed. The door was kept closed throughout the procedure. [redacted] was the Resident Dentist and [redacted] was the Dental Assistant during this procedure.

See Tables 5 and 6 for results on page 9.

5/15/08

On 5/15/08, a Foxboro 100XL Sapphire Analyzer was utilized to collect instantaneous samples during dental procedures. This device was used to pinpoint sources of leaks emanating from the N2O delivery and scavenging system currently in use in the Pediatric Clinic. This was a real time assessment of N2O levels in and around the procedures which allowed for an assessment of the integrity of the anesthetic gas system. In addition work practices could be linked to peak levels found during the direct read assessments.

In the "quiet room" instantaneous N2O levels were found in the range of 159ppm-585ppm. Connection points in tubing, adapters, and flow meters were all found to have elevated levels of N2O. The highest level of 585ppm was found three feet above the head of the patient. During the sample collection process it was found that the scavenging system tubing had a pinch at the vacuum tube holder. This was most likely a direct link to the elevated results found during the direct read assessment.

In the open area of the Pediatric Clinic leak testing along the N2O delivery and scavenging system found results between 1.2ppm-49ppm. One peak level of 109.7ppm was found near the breathing zone of the dental assistant. It was noted that a gust of wind appeared to blow in from the adjacent window at the time of this reading. All other instantaneous readings along the N2O system had minor leaks that averaged around 3-5ppm.

5/19/08

On 5/19/08, leak testing with the Foxboro 100XL Sapphire Analyzer in the Pediatric Clinic was repeated in the open area of the clinic. Instantaneous leak tests along the N2O delivery and scavenging system found levels between 2.5ppm-15.2ppm. These results indicate minimal leakage from the N2O system on this sample date.

METHODS

Personal and area monitoring was performed for N2O by using Assay Technology Nitrous Oxide monitors (Model #X575 AT). The samples were taken for the duration of the dental process, which averaged between 30 minutes and hour. The results in ppm were the total concentrations collected during the procedures. There is no Time Weighted Average (TWA) calculation for N2O.

The monitors were shipped to Assay Technologies in Pleasanton, California to be analyzed using a simulated OSHA method #166 for Nitrous Oxide.

Direct reading for N2O was performed using a Foxboro 100XL Sapphire Analyzer. This direct read unit was rented from Ashtead Technology Rentals, Rochester, NY. Calibration verification of the unit was provided by Ashtead. The unit was field calibrated for N2O each morning before measurements were collected.

RESULTS AND CONCLUSION

The results of the exposure monitoring are presented in the following tables. The 8 hour time weighted average (TWA) for the collected exposure samples were found to be below the ACGIH TLV for the majority of collected samples. Those TWA levels that exceed the ACGIH TLV were mainly collected from dental residents during the procedures. All total sample results for N2O were shown to be above both the NIOSH recommended limit of 25 ppm and the ACGIH threshold limit value of 50 ppm. All but two total samples were substantially above this guideline.

This data suggest that there was significant exposure to N2O during operatory procedures due to work practice and malfunctioning equipment. The samples consistently show the highest exposure for the resident dentists. The dentists are almost always closest to the patient right in front of their mouths where there is the highest potential for exposure.

Considering the high levels found during multiple procedures faulty equipment and work practices are most likely connected to the results. The lack of use or improper use of these systems may be contributing to the high levels found.

Direct reading instantaneous samples colleted with the Foxboro 100XL Sapphire Analyzer indicated a connection to work practice and equipment issues in regard N2O exposure. For the direct reading assessment that took place on 5/15/08 in the "quiet room" results were elevated for all instantaneous samples collected. The scavenging hose for the N2O system in this room was kinked during the first half of the procedure. This cut off suction to the scavenging system allowing excess N2O to accumulate in the "quiet room". The cutting off of the scavenging system most likely increased leaks found at connection points along the system. This indicates a need for stricter maintenance on all N2O equipment and stricter guidelines on safe work practices for setting up and using the N2O delivery and scavenging system.

The direct reading instantaneous results collected on 5/19/08 in the open area of the clinic indicated that the equipment functioned properly and appropriate work practices were followed.

Table 1. Monitoring Results for Nitrous Oxide
3/27/08 Open area of Clinic

Sample Date	Employee/ Area Monitored	8-hour TWA	Total Results	ACGIH [TLV]	NIOSH [REL]
03/27/08	[redacted] [Operating dentist]	205ppm	2900ppm	50 ppm	25 ppm
	[redacted] [dental hygienist]	63.75ppm	850ppm		
	N2O Tank Unit [area sample]	25.43ppm	330ppm		
	[redacted] [15 minute sample]		1600 ppm		

ppm – denotes parts per million
TWA – denotes time weighted average for an 8 hour work day

Table 2. Monitoring Results for Nitrous Oxide
3/27/08 "Quiet Room"

Sample Date	Employee/ Area Monitored	8-hour TWA	Total Results	ACGIH [TLV]	NIOSH [REL]
03/27/08	[redacted] [Operating dentist]	54.4ppm	450ppm	50 ppm	25 ppm
	N2O Tank Unit [area sample]	25.3ppm	190ppm		

ppm – denotes parts per million
TWA – denotes time weighted average for an 8 hour work day

Table 3. Monitoring Results for Nitrous Oxide
4/22/08 Open area of Clinic

Sample Date	Employee/ Area Monitored	8-hour TWA	Total Results	ACGIH [TLV]	NIOSH [REL]
04/22/08	[redacted] [Operating dentist]	18.75ppm	250ppm	50 ppm	25 ppm
	[redacted] [dental hygienist]	15ppm	200ppm		
	N2O Tank Unit [area sample]	14.8ppm	210ppm		

ppm – denotes parts per million
TWA – denotes time weighted average for an 8 hour work day

Table 4. Monitoring Results for Nitrous Oxide
4/22/08 "Quiet Room"

Sample Date	Employee/ Area Monitored	8-hour TWA	Total Results	ACGIH [TLV]	NIOSH [REL]
04/22/08	[redacted] [Operating dentist]	258.75ppm	2700ppm	50 ppm	25 ppm
	[redacted] [dental hygienist]	27ppm	360ppm		
	N2O Tank Unit [area sample]	24.1ppm	290ppm		

ppm – denotes parts per million
TWA – denotes time weighted average for an 8 hour work day

Table 5. Monitoring Results for Nitrous Oxide
4/23/08 Open area of Clinic

Sample Date	Employee/ Area Monitored	8-hour TWA	Total Results	ACGIH [TLV]	NIOSH [REL]
04/23/08	[redacted] [Operating dentist]	79.9ppm*	340ppm	50 ppm	25 ppm
	[redacted] [dental hygienist]	5.3ppm	75ppm		

ppm – denotes parts per million
TWA – denotes time weighted average for an 8 hour work day

Table 6. Monitoring Results for Nitrous Oxide
4/23/08 "Quiet Room"

Sample Date	Employee/ Area Monitored	8-hour TWA	Total Results	ACGIH [TLV]	NIOSH [REL]
04/23/08	[redacted] [Operating dentist]	79.9ppm*	570ppm	50 ppm	25 ppm
	[redacted] [dental hygienist]	8.1ppm	83ppm		

ppm – denotes parts per million
TWA – denotes time weighted average for an 8 hour work day

* - The TWA for [redacted] was made by combining both exposure events in order to calculate her 8 hour TWA.

DISCUSSION & RECOMMENDATIONS

Based on the results of monitoring and observations made during the sampled procedures, EH&S has the following recommendations.

1. All equipment must be checked for leakage before any procedures. Check all rubber hoses, connections, tubing, and breathing bags. Replace items when damaged or when recommended by the manufacturer. Perform leak testing of the equipment by using a soap solution to check for bubbles at high-pressure connections. Check both high-and low-pressure connections (such as O-rings) regularly, as they may become worn. Replace tank equipment periodically according to the manufacturer's recommendations. Preventative maintenance on all N2O manifold systems should be investigated so that outside technicians are regularly maintaining and checking the tank manifolds in use.

2. A set of work practices must be established to prevent excess nitrous oxide in the operatory. Supply scavenging masks in a variety of sizes so that the mask always fits comfortably and securely over the patient's nose or face. When dealing with children, use an immobilizer for the head in addition to the Velcro body wrap for patients or procedures that may be more difficult. Based upon the direct reading results from the 5/15/08 assessment in the "quiet room" work practices are crucial in reducing occupational exposure. During that assessment a kinked scavenging hose most likely caused the elevated levels of N2O during the procedure. During future training sessions it is very important to share information on appropriate work practice and assure that employees responsible for the N2O delivery and scavenging system know how to maintain the equipment properly. Without appropriate work procedures in place employee error will continue to contribute to N2O exposure.

3. Determine the air exchanges in each operatory area and consider increasing general ventilation if necessary. If general ventilation can not be increased, a local ventilation system would reduce fugitive N2O exposure in the operatories where N2O is used.

4. Training for Nitrous Oxide exposure has been conducted for Pediatric Clinic employees. This training is being continued on 5/22/08 & 5/23/08 in order to inform employees about their potential exposure while working within the Pediatric clinic. In addition this training will include best work practices so that employees can incorporate work practices that will reduce exposure.

5. A reevaluation of the scavenging system has been conducted by a medical technician. Problems were found with the Automatic Vacuum System (AVS) during that inspection. Discussions are currently on going with Pediatric

Clinic supervisors on how to make the appropriate changes in equipment. More sophisticated systems should be investigated to simplify the use of the scavenging systems in the Pediatric Clinic.

6. An interlock system should be investigated so that N2O can not be administered to the patient unless the scavenging system is operational.

REFERENCES

Corbett TH, Cornell RG, Endres JL, Millard RI [1973]. Effects of Low Concentrations of Nitrous Oxide on Rat Pregnancy. Anesthesiology 39:299B301.

Ellenhorn, M.J., S. Schonwald, G. Ordog, J. Wasserberger. Ellenhorn's Medical Toxicology: Diagnosis and Treatment of Human Poisoning. 2nd ed. Baltimore, MD: Williams and Wilkins, 1997. 1495

NIOSH [1977b]. Criteria for a Recommended Standard: Occupational Exposure to Waste Anesthetic Gases and Vapors. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 77B140.

Rowland AS, Baird DD, Weinberg CR, Shore DL, Shy CM, Wilcox AJ [1992]. Reduced Fertility Among Women Employed as Dental Assistants Exposed to High Levels of Nitrous Oxide. New Eng J Med 327(14):993B997.

Vieira E, Cleaton-Jones JP, Austin JC, Moyes DG, Shaw R [1980]. Effects of Low Concentrations of Nitrous Oxide on Rat Fetuses. Anesth and Analgesia 59(3):175B177.

Vieira E, Cleaton-Jones P, Moyes D [1983]. Effects of Low Intermittent Concentrations of Nitrous Oxide on the Developing Rat Fetus. Br J Anaesth 55:67B69.